EVALUATION OF BLACK SEA BASS POT GEAR CLOSURE ALTERNATIVES IN SOUTH ATLANTIC SNAPPER-GROUPER REGULATORY AMENDMENT 16

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SUMMARY

Since 2012, the South Atlantic Fishery Management Council (SAFMC) has made several changes to the management of black sea bass (*Centropristis striata*) in federal waters, including a pot gear endorsement program, pot gear limits, over a twofold increase to the annual catch limit (ACL), trip limits, and a change in the fishing season from June-May to Jan-Dec. Through Regulatory Amendment 16 to the Snapper-Grouper Fishery Management Plan (Reg-16), the SAFMC is considering opening the commercial black sea bass pot season when federally-protected whales occur in the mid-Atlantic and Southeast regions (i.e., Nov 1-Apr 30). The western North Atlantic right whale (*Eubalaena glacialis*) is one of the most endangered large whales in the world, with as few as 455 individuals remaining. As entanglement in fixed fishing gear, such as pot gear, is a leading cause of human-induced right whale mortality, the SAFMC has proposed a variety of spatiotemporal closure alternatives that may potentially mitigate this risk. This analysis simulated the potential landings of black sea bass pot endorsement holders during a winter season under each of the proposed alternatives. Factoring in landings by other gears, the date the ACL would be met under each scenario was predicted. The analysis also considered the seasonal distribution of black sea bass pot gear and North Atlantic right whales to compare the relative risk of right whale entanglements under each of the proposed spatial closure alternatives. Because pot gear hasn't been fished during the Nov-Apr time period since a two-week opening in Dec 2010, uncertainty in possible pot gear winter catch rates under current regulations was addressed using four proxies for winter catch rates. Similarly, uncertainty in the location of winter fishing effort under current regulations was addressed using three different proxies for winter fishing effort. Monthly whale distributions off FL-SC were modeled following Gowan and Ortega-Ortiz (2014) under mean, warmer-than-average, and colder-than-average conditions. Due to limited sightings effort off NC, whale distributions off NC were modeled using all months combined following a similar regression approach as Gowan and Ortega-Ortiz (2014); annual and monthly NC models were developed by fitting the final model to mean Nov-Apr environmental conditions and mean monthly conditions, respectively. Within model uncertainty was addressed using the upper and lower confidence bounds of the model predicted fits. The entanglement risk to right whales from pot gear was modeled as the co-occurrence of black sea bass effort and right whale relative abundance on a relative scale from 0 (no pot gear opening) to 100 (complete opening to pot gear). Although a broad range of sensitivity runs were considered, the relative differences between alternatives were consistent. Most Reg-16 proposed alternatives are anticipated to result in-season quota closures to prevent the ACL from being exceeded. Of the proposed alternatives, Alternatives 1, 7b, 8b, 9b, 6, 4, 5, and 7c would result in the longest fishing seasons (listed in order). Alternatives 1, 6, and 4 would result in the lowest relative entanglement risk for right whales. Alternatives 7c, 7b, 2, 9b, and 7a would result in the highest relative entanglement risk.

INTRODUCTION

The South Atlantic Fishery Management Council (SAFMC) manages black sea bass (*Centropristis striata*) in federal waters from the Florida Keys to Cape Hatteras, North Carolina. The current allocation is 57% recreational and 43% commercial. For the past several years, the fishing year for black sea bass ran from June 1-May 31. In the past several years, recreational and commercial black sea bass fishing has been subject to quota closures shortening the fishing year (e.g., recreational: 12 Feb 2011, 17 Oct 2011; commercial: 15 May 2009, 20 Dec 2009, 7 Oct 2010, 15 July 2011, and 8 Oct 2012). In 2012, the SAFMC implemented Snapper-Grouper Amendment 18A, which established a black sea bass pot endorsement program where a commercial vessel with an Unlimited Snapper-Grouper Permit may harvest black sea bass using pot gear only if the vessel also has a black sea bass pot endorsement (SAFMC 2012). Amendment 18A also implemented a limit of 35 black sea bass pot tags issued to each of the 32 black sea bass pot gear endorsement holders each permit year, a 1,000 pound (lb) gutted weight (gw) trip limit, an increase in the commercial minimum size limit from 10 inches to 11 inches total length, and a requirement that pots be returned to shore at the end of each trip. In 2013, the SAFMC implemented Regulatory Amendment 19 (Reg-19), which increased the black sea bass commercial annual catch limit (ACL) from 309,000 lb gw to 661,034 lb gw (in 2015) based on the results of the latest stock assessment (SAFMC 2013). In 2014, the SAFMC implemented Regulatory Amendment 14 (Reg-14), which changed the commercial fishing season for black sea bass to Jan 1-Dec 31 (starting in 2015), implemented a 300-lb gw hook-and-line trip limit for Jan-Apr, and a 1,000-lb gw hook-and-line trip limit for May 1-Dec 31. See Appendix A for a visual on management history.

Due to the substantial increase in the ACL via Reg-19, there was potential that the commercial black sea bass pot season would remain open when federally-protected whales occur in the mid-Atlantic and Southeast regions (i.e., Nov 1-Apr 30) for the first time since Dec 2010 (Figure A2). Entanglement in fixed fishing gear, such as pot gear, is a leading cause of human-induced western North Atlantic right whale (*Eubalaena glacialis*) mortality (Knowlton *et al.* 2012, Waring *et al.* 2014). To minimize the probability of entanglement of ESA-listed whales in black sea bass pot gear, Reg-19 implemented an annual prohibition on the use of black sea bass pots from Nov 1-Apr 30 in conjunction with the ACL increase.

The SAFMC, through Regulatory Amendment 16 (Reg-16), is currently considering shortening the black sea bass pot closure season and/or spatially designating the closure boundaries (SAFMC 2014). The purpose of Reg-16 is to reconsider the annual November 1 through April 30 prohibition on the use of black sea bass pot gear. The need for the amendment is to minimize socioeconomic impacts to black sea bass pot endorsement holders while considering the need to protect ESA-listed whales in the South Atlantic region. This analysis considers the potential landings of black sea bass as well as the risk to right whales that might occur under the alternatives of Reg-16 (Appendix B). This analysis does not address any reductions in entanglement risk that might result from Reg-16 Action 2, which proposes to modify buoy line/weak link gear requirements and buoy line rope marking for black sea bass pots required by the Atlantic Large Whale Take Reduction Plan (ALWTRP).

Black Sea Bass

Prior to the inception of the Southeast Data Assessment and Review (SEDAR) process, the SAFMC-managed stock of black sea bass was assessed using tuned virtual population analysis models. Using data through 1990, Vaughan et al. (1995) concluded that overfishing was occurring during the 1980s. Subsequently, with data through 1995, Vaughan et al. (1996) estimated that the rate of overfishing had increased during the 1990s. South Atlantic black sea bass was first assessed through the SEDAR process in 2002 (SEDAR-02). SEDAR (2002) applied a statistical catch-age formulation as the primary model. It estimated that the rate of overfishing had increased through the 1990s and that the stock was overfished. The SEDAR-02 assessment was updated in 2005 with data through 2003 (SEDAR Update Process #1). The update assessment estimated that the rate of overfishing continued to increase into the 2000s and that the stock remained overfished. The SEDAR 25 Update (2013) concluded that black sea bass were no longer overfished and that overfishing was not occurring. The stock was very close to B_{MSY} (B_{2012}/B_{MSY}=0.96) and the SSB in 2012 was just above SSB_{MSY} (SSB_{2012}/SSB_{MSY}=1.032). SSB in 2012 was estimated to be above SSB_{MSY}, indicating that the stock was rebuilt. Spawning stock biomass decreased significantly from the beginning of the assessment period, dropping below SSB_{MSY} in 1989, until finally stabilizing and remaining at a low level from 1994-2007. The SSB increased consistently since 2008, crossing SSB_{MSY} in the terminal year of the assessment. SEDAR-25 Update (2013) estimated current fishing mortality (F) was well below F_{MSY} ($F_{Current}/F_{MSY}$=0.659). The trend in F showed a rapid increase from the late-1970s until 1988, when it surpassed F_{MSY} by a significant amount. F remained above F_{MSY}, with large inter-annual variability, until it dropped below F_{MSY} in 2011. The rebuilding of the black sea bass stock allowed the SAFMC to increase the ACL over twofold via Reg-19.

North Atlantic Right Whale

The western North Atlantic right whale is one of the most endangered large whales in the world (Clapham et. al. 1999). The species' known range extends from calving grounds in coastal waters of the southeastern United States to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Waring *et al.* 2014). The western North Atlantic right whale population size was estimated to be at least 455 individuals in 2010 (447 cataloged whales plus 8 not cataloged calves at the time the data were received) based on a census of individual whales identified using photo-identification techniques (Waring *et al.* 2014). The species is listed as "Endangered" under the Endangered Species Act, "Depleted" under the Marine Mammal Protection Act, and under CITES Appendix I throughout its range. As such, North Atlantic right whales are afforded many legal protections.

Right whales may be found from Florida to North Carolina from November 1 through April 30 (NMFS 2008). The coastal waters of the southeastern United States are a wintering ground and the sole known calving area for the North Atlantic right whale. Sighting records of right whales spotted in the core calving area off Georgia and Florida consist of mostly mother-calf pairs and juveniles but also some adult males and females without calves (Jackson *et al.* 2012a). Most calves are likely born early in the calving season. As many as 243 right whales have been documented in the southeastern U.S. during one calving season (P. Hamilton, personal communication, April 11, 2014). Studies indicate that right whale concentrations are highest in the core calving area from November 15 through April 15 (NMFS 2008). Residency patterns for non-calving right whales are typically less than one month (A. Krzystan, June 2014 SEIT meeting) indicating a steady stream of right whales travel between habitats in the northeastern and southeastern U.S. during fall, winter, and spring. Thus, movements within and between habitats are extensive, with telemetry data and aerial observations suggesting the area off the mid-Atlantic states is an important migratory corridor (Brown and Marx 2000, Mate *et al.* 1997, Baumgartner and Mate 2005). Furthermore, systematic surveys conducted off the coast of North Carolina during the winters of 2001 and 2002 sighted eight calves, suggesting the calving grounds may extend as far north as Cape Fear (McLellan *et al.* 2004). Four of the calves were not sighted by surveys conducted farther south. One of the cows photographed was new to researchers, having effectively eluded identification over the period of its maturation (McLellan *et al.* 2004).

The small population size and low annual reproductive rate of North Atlantic right whales suggest that human sources of mortality may have a greater effect relative to population growth rates than for other whales (Waring *et al.* 2014). The principal factors believed to be retarding growth and recovery of the population are ship strikes and entanglement with fishing gear (Waring *et al.* 2014). Young whales, ages 0-4 years, are especially vulnerable (Kraus 1990), and an analysis of the population age structure suggests that it contains a smaller proportion of juvenile whales than expected (Hamilton et al. 1998; Best et al. 2001), which may reflect lowered recruitment and/or high juvenile mortality. Fishery entanglement is the largest known source of human-caused mortality and serious injury to right whales (Waring *et al.* 2014), and juveniles and calves entangle at a higher rate than adults (Knowlton *et al.* 2012). A recent study found that approximately 83% of all right whales have been entangled at least once, and 60% of those animals had been entangled multiple times (Knowlton *et al.* 2012). The authors further clarify that this is a minimum estimate (Knowlton *et al.* 2012).

The number of human caused serious injury and deaths caused by fishery entanglements alone far exceed the MMPA potential biological removal (PBR). The MMPA defines PBR as the maximum number of animals, not including natural mortalities, which may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (16 U.S.C. 1362). For the Western Atlantic stock of the North Atlantic right whale, PBR is 0.9 (Waring *et al.* 2014). Based on data from 2007-2011, the minimum rate of annual human-caused mortality and serious injury to right whales averaged 4.05 per year; 3.25 per year were attributed to incidental fishery entanglement and 0.8 per year were attributed to vessel strike. These numbers represent the lower bound of estimated human caused mortality (Waring *et al.* 2014). Thus, the current rate of fishery entanglements averages 3.25 animals per year and is 3.6 times over PBR. Therefore, any serious injury or mortality for this stock is significant (Waring *et al.* 2014). NMFS is working to reduce serious injury and mortality through the ship speed limit rule and through the ALWTRP. Section 118 of the MMPA mandates that the ALWTRP reduce mortality and serious injury of right whales to below PBR.

Entanglements incidental to commercial fishing are the primary threat to right whales, however less is known about the source of entanglement. In a study of 31 right whale entanglements, Johnson et al. (2005) found 14 cases where gear type could be identified; pot gear represented 71% of these cases (8 lobster pots, 1 crab pot, 1 unknown pot). In a recent compilation of data from 2007-2014, there were 17 entangled whales and none of these were attributed to a specific fishery (Waring *et al.* 2014). As evidenced by these compilations, information from an entanglement event often does not include the detail necessary to assign the entanglements to a particular fishery or location, and scarring studies suggest the vast majority of entanglements are not observed (Waring *et al.* 2014). Consequently, while black sea bass gear has not been definitively identified in the few cases when gear was identified to fishery, it also cannot be ruled out as gear that has resulted in serious injuries or deaths to right whales.

Evaluation of Reg-16 Alternatives

The analysis simulates the potential landings of black sea bass pot endorsement holders during a winter season under each of the proposed alternatives. Factoring in landings by other gears, the date the ACL would be met under each scenario is predicted. The analysis also considers the seasonal distribution of black sea bass pot gear and North Atlantic right whales to compare the relative risk of right whale entanglements under each of the proposed spatial closure alternatives.

METHODS

Data Sources

Through the Southeast Fisheries Science Center (SEFSC) Logbook program (SEFSC Logbook, accessed 22 July 2014), federally-permitted commercial fishermen self-report landings on a trip level, providing species-specific landings (lb), primary gear used, and primary area fished. Primary depth of capture has also been reported from 2004 onward. A single area and depth of fishing is reported in the commercial logbooks for each species per trip, although fish may be encountered in many areas and depths during multiple sets. The SEFSC Commercial ACL dataset contains aggregated dealer records of monthly catch by gear and species, and includes landings from vessels with and without federal permits through 2013. The Atlantic Coastal Cooperative Statistics Program (ACCSP) assimilates dealer trip tickets into a database of monthly catch by gear and by species, including landings from vessels with and without federal permits (ACCSP Trip Ticket data, accessed by SEFSC 12 Sept 2014).

Landings using gear other than pot gear were summarized by fishing year and fishing month from 2002-2013 using the SEFSC ACL dataset and 2013-2014 from the ACCSP Trip Ticket data. Landings using pot gear were summarized by fishing year and fishing month from 1998-2014 for federally-permitted pot gear endorsement holders using SEFSC Logbook data. The 1,000 lb gw trip limit and 35-pot limit implemented by Amendment 18A were simulated in the time series. Any trip catching more than 1,000 lb gw was scaled down to 1,000 lb gw. Landings for trips using greater than 35 pots were scaled down based on the average catch-per-pot multiplied by 35 pots. Trip and pot limits were not simulated for the 2012/13 or 2013/14 fishing years, as these regulations were already in place for that period. No additional simulations were performed to estimate additional trips that may have occurred in the past if pot and trip limit restrictions had been in place.

Spatial Distribution of Landings and Effort

Season and water depth are important drivers of the spatial distribution of landings and effort and are therefore important to consider when comparing the alternatives in Reg-16. Seasonal trends in catch rates per pot haul and depth of fishing were compared across fishing seasons. Using a Geographic Information System (GIS; ESRI ArcGIS 10.1), landings for 2013/14 (the most recent season), 2008/09 (the most recent Nov-Apr winter season), and 2006/07-2008/09 (the average of the last three winter seasons) were evaluated to compare spatial distribution of catch.

The impacts of the spatial closures in Reg-16 were evaluated by first assigning pot landings to area-depth grids. Landings were assumed to be homogenous within an area-depth grid. Logbook pot gear landings were then eliminated from the time series proportional to the amount of area covered by the proposed closure alternative during the closed season and the remaining landings were compared to Alternative 1, which assumed landings in 2015 would proceed at the same pace as 2013/14.

Three scenarios were tested: (A) based on the spatial distribution of pot gear endorsement holder landings under simulated Amendment 18A regulations for the Nov-May period of the 2008/09 season, (B) based on the spatial distribution of pot gear endorsement holder landings during the June-Oct period of the 2013/14 season, and (C) based on the spatial distribution of pot gear endorsement holder landings under simulated Amendment 18A regulations for the Nov-May period averaged across the 2006/07, 2007/08, and 2008/09 seasons. By comparing spatial closure impacts to the baselines of a 100% closure and a 100% opening for each scenario, and expressing these comparisons as a percentage, the analysis controls for changes in the magnitude of black sea bass landings through time. Scenario A assumes no change in the spatial distribution of pot gear fishing pressure would have taken place between the 2008/09 and projected 2015 season. Scenario B assumes no change in the spatial distribution of pot gear fishing pressure would take place between the June-Oct period of the recent 2013/14 season and the Nov-May period of the projected 2015 season. Scenario C assumes no change in the spatial distribution of pot gear fishing pressure between the projected 2015 season and the mean distribution of fishing pressure during the past three winter seasons (e.g., 2006/07 to 2008/09). As such, Scenarios A and C address winter/summer differences in spatial fishing pressure, and Scenario B addresses regional differences in fishing pressure that have emerged over the past 5 years where the black sea bass commercial pot gear fishery has been partially or completely closed during the Nov-May time period. Spatial distributions of pot gear prior to 2006 were not considered due to changes in the fishery and a lack of consistently reported depth of fishing in logbooks.

Catch Rate Projections

Projected landings were expressed as daily catch rates uniformly distributed within each fishing month. ACCSP Trip Ticket landings using gears other than pot gear ("other gear") for June-May from the 2013/14 fishing year were used in projections because a substantial increase in "other gear" landings was observed following implementation of Amendment 18A, which restricted utilization of pot gear to federally-permitted endorsement holders only. Pot gear in ACCSP data was defined only as gear code 139 ("Pots and Traps, Fish"). Reg-14 will implement a 300-lb gw trip limit for Jan-Apr and a 1,000-lb gw trip limit for May-Dec for hook and line gears. The impacts of these trip limits were simulated by examining ACCSP Trip Ticket records from 2013/14 and setting any landings for hook and line gears exceeding the trip limit for a given month equivalent to the trip limit.

Under all scenarios, catch rates for pot gear for June-Oct were assumed equivalent to pot gear catch rates observed during the 2013/14 season. Since the months under consideration in the alternatives in Reg-16 have not been open to pot gear fishing for several years, four projection scenarios were developed to express the potential pot gear catch rates during Nov-May. Computations were performed using catch-per-pot rather than catch-per-pot-haul because the number of hauls prior to the 2013/14 season had some misreporting issues due to confusion on how to complete the commercial logbook forms (SEFSC, pers. comm.). Thus, catch rates reported below are cumulative and may reflect multiple hauls. Under Scenario 1, catch rates for pot gear from Nov-May were set equivalent to catch rates for the 2008/09 season (the last fully open winter season), computed as catch-per-pot for pot endorsement holders under a 35-pot limit and 1000-lb gw trip limit, multiplied by the number of pots that were used during 2008/09 under a simulated 35-pot limit. Under Scenario 2, catch rates for pot gear from Nov-May were computed assuming Nov-May effort would be equivalent to the number of pots that were used during 2008/09 under a simulated 35-pot limit, and catch-per-pot would be equivalent to 2013/14 observed Oct catch-per-pot scaled by the observed ratios of Oct 2008/09 catch-per-pot to Nov-May 2008/09 catch-per-pot. For example, October 2013 catch-per-pot was 26.94 lbs gw/pot, and October 2008/09 catch-per-pot haul was 15.00 lbs gw/pot, 52.78% of the maximum catch-per-pot observed in the 2008/09 season (January 2009's 28.42 lbs gw per pot). The ratio-scaled January pot landings would be 103,871 lbs gw (100%/52.78% × 26.94 lbs gw/pot × 2,035 pots used in January 2009 under a simulated 35-pot limit per vessel-trip). Under Scenario 3, Nov-May catch rates were assumed equal to observed Oct 2013/14 catch rates. Under Scenario 4, Nov-May catch rates were assumed equal to mean Nov-May catch rates from the past three winter seasons (e.g., 2006/07-2008/09).

Right Whale Spatial Distribution Model

Season and habitat characteristics are important drivers of right whale occurrence and are important to consider under all Reg-16 alternatives to ensure adequate protection for endangered right whales. Gowan and Ortega-Ortiz (2014) developed a temporally dynamic habitat model to predict wintering right whale distribution between Florida and South Carolina using a generalized additive model framework and aerial survey data (see Appendix D for link to free online manuscript). The model summarized whale sightings from surveys in the southeastern United States (SEUS Survey: 2003/04-2012/13), survey effort corrected for probability of whale detection, and environmental data at a semimonthly resolution. A generalized additive model (GAM) was used to relate the number of right whale sightings to predictor variables. Because the response variable, number of sighted whales, was overdispersed and zero-inflated due to the large number of sampling units (96%) with no sightings, Gowan and Ortega-Ortiz (2014) used a hurdle model. A quasibinomial distribution (to deal with excessive number of zeros) with a logit link was used to model presence-absence from all data, and a gamma distribution with a log link was used to model the number of whales from sampling units with whale sightings. Predicted relative abundance was calculated by multiplying the probability of occurrence, derived from the first model, by the expected number of whales, derived from the second model. Model selection was accomplished with a forward stepwise selection procedure, using the following evaluation criteria: model GCV scores, percentage of deviance explained, and analysis of deviance tests. Five-fold cross-validation was used to evaluate each candidate model's predictive ability, and was repeated five times, with mean average squared prediction error (ASPE) used to assist in model selection. Final specification of the selected best model used to estimate smoothing functions and create prediction maps was based on the complete dataset.

Under the best model specification, sea surface temperature (SST), water depth, and survey year were significant predictors of right whale relative abundance. Additionally, distance to shore, distance to the 22°C SST isotherm, and an interaction between time of year and latitude (to account for the latitudinal migration of whales) were also selected. Predictions from the model revealed that the location of preferred habitat differs within and between years in correspondence with variation in environmental conditions. Although cow-calf pairs were rarely sighted in the company of other whales, there was minimal evidence that the preferred habitat of cow-calf pairs was different than that of whale groups without calves at the scale of this study. The results of this updated habitat model were averaged by month, across all years, to represent right whale distribution, expressed as an encounter rate (i.e., expected number of whales sighted in each grid cell, given observed SST, annual sighting rate, and uniform survey effort). To bookend the spatial distribution of right whales under different environmental conditions, sensitivity runs were conducted for model-predicted spatial distributions under a warmer-than-average winter (i.e., 2011/12) and a colder-than-average winter (i.e., 2009/10).

An additional model was developed by T. Gowan (FWC/FWRI) for North Carolina using survey data collected by the University of North Carolina, Wilmington (UNCW Survey: 10/2005-4/2006, 12/2006-4/2007, 2/2008-4/2008). Survey effort data was obtained from OBIS-Seamap, and was expressed as the cumulative number of surveys per cell, across all survey months and years. The number of sightings was calculated as the cumulative number of right whales per cell, across all months and years. Distance to shore, depth, SST, and slope were calculated as in Gowan and Ortega-Ortiz (2014). Due to limited data, no temporal framework was introduced into the model; cumulative sightings and effort data were used with long-term winter SST. A generalized additive model (GAM) with a quasibinomial distribution (to handle excessive zeroes) with a logit link was used to model presence-absence of right whale sightings, with log(Surveys) used as an offset term. Predictor variables considered were log(Depth), log(Slope), distance to shore, and average SST. The basis dimension parameter was set to 3 and the gamma term was set to 1.4 to avoid overfitting. Following Gowan and Ortega-Ortiz (2014), model selection was accomplished with a forward stepwise selection procedure, using the following evaluation criteria: model generalized cross validation (GCV) scores, percentage of deviance explained, analysis of deviance tests, and average squared prediction error from a five-fold cross-validation. Predicted values from the North Carolina model did not have the same scale or interpretation as the predictions from the Florida-South Carolina model (Gowan and Ortega-Ortiz 2014), and were not directly comparable due to differences in survey design, resolution/quantification of survey effort, temporal components in the model, model framework (probability of presence vs. relative abundance), whale behavior (e.g. sighting availability bias in migratory corridor vs. calving grounds), etc. See Appendix C for further details on the North Carolina right whale sightings model.

Relative Risk of Right Whale Entanglement in Pot Gear Vertical Lines

The relative risk to right whales from pot gear was modeled by overlaying black sea bass effort and right whale relative abundance. Black sea bass pot gear effort was expressed as monthly totals of soak time across all vessels, assigned to commercial logbook area and binned into 5 m depth intervals. Because right whale entanglement rates in pot gear are unknown but greater than 0% and any vertical line in the water column has been determined to pose an entanglement risk (Johnson *et al.* 2005), this analysis assumes that the overlay of pot gear soak time and right whale distribution is a proxy for entanglement risk to right whales. Right whale encounter rates were modeled using the FL-SC and NC right whale spatial distribution models discussed above.

Three black sea bass effort distribution scenarios were considered; Scenario A was based on the winter of the 2008/09 fishing year, Scenario B was based on the summer of the 2013/14 fishing year, and Scenario C was based on the mean distribution during the winters of the 2006/07-2008/09 fishing years. Various reporting issues (discussed below) and substantial changes in fishing practices since the implementation of the 35-pot limit, the pot gear endorsement, and the requirement to bring pots in at the end of the trip made effort data (i.e., soak times and number of hauls) for black sea bass pot gear less reliable for previous seasons. Reliable effort data was obtained for the 2013/14 fishing year after a targeted reconciliation process (SEFSC, pers. comm.). Because pot fishing was prohibited in the winter of the 2013/14 fishing year, the spatial distribution of fishing effort for the 2013/14 scenario was treated as the total effort within area-depth bins across months with complete data that were open to pot fishing (i.e., June-Oct 2013).

The 2008/09 fishing year was the most recent period when pot fishing took place during Nov-Apr, but effort data for this fishing year ('Scenario A') and prior years ('Scenario C') was not considered reliably reported for pot gear due to misunderstandings among fishermen regarding how to report hauls and soak times (SEFSC, pers. comm.). To handle this concern, the spatial distribution of pots from winter fishing seasons was utilized in Scenarios A and C, but pot soak-times were assigned to area-depth bins for these Scenarios using reconciled 2013/14 soak time data to approximate future soak times during Nov-Apr. For example, under Scenario A, effort data were back-filled for the 2008/09 fishing year by multiplying 2013/14 mean soak time per pot by the number of pots reported in 2008/09 for each area-depth grid. The number of pots used on a given trip in 2008/09 was retrospectively capped at 35 to reflect current regulations. Mean pot soak times were assigned by linkage under the following hierarchy: vessel+area+depth, vessel, owner, area+depth, area, region. This approach assumed that the soak-times of a given vessel in a given area-depth grid from summer 2013/14 would not differ substantially in a winter season. If a vessel fished in a given area-depth grid in 2008/09 but not in 2013/14, then the mean soak-time across all trips for that vessel in 2013/14 was multiplied by the number of pots reported in the given area-depth grid in 2008/09. If that vessel did not fish in 2013/14, but the owner of that vessel did fish, the owner's mean soak-time across all trips was used. If there were no matches for the vessel or the owner between the 2013/14 and 2008/09 fishing years, then the mean soak-time across all vessels in that area-depth grid in 2013/14 was used as the multiplier, and so forth. The monthly spatial distribution of recomputed soak-times for the 2008/09 fishing year was summed by area-depth grid for Nov-Apr.

The three effort distribution scenarios were entered into a GIS geodatabase. Effort was assigned to area-depth grids using a generalized 5 m bathymetric bin polygon layer developed using the NGDC Coastal Relief Model sliced by the South Atlantic commercial logbook grid layer. The FL-SC and NC right whale encounter rate models were also input into the geodatabase. In the area where the FL-SC model predictions and the NC model predictions overlapped, the NC model predictions were removed in favor of the more statistically robust FL-SC model. All models were projected as Albers Equal Area Conic. The areas of all polygon cells were computed. The right whale encounter models (i.e. predicted sightings/habitat models) were clipped to the commercial area-depth grids, and the areas within each right whale encounter sub-grid were computed. Right whale encounter rate was summarized as a weighted mean within area-depth grids, with the weights based upon the areas of the right whale encounter sub-grids. For each area-depth grid, the weighted mean of right whale encounters was then multiplied by the total commercial pot gear effort within the area-depth grid. The products of mean encounter rates and commercial effort were summed across all depth-grids and used as the baseline for the analysis of the impacts of the spatial closure alternatives on potential right whale interactions with pot gear vertical lines. This baseline assumes a complete opening of SAFMC waters to pot gears; the maximum possible daily exposure of right whales to entanglement risk until a quota closure is reached. Thus, the comparison of Alternatives would range from 0% (Alternative 1: EEZ closed Nov-Apr) to 100% (no closed area) relative right whale risk. To evaluate the impacts of different spatial closure alternatives, the area-depth grid layer was clipped to each spatial closure alternative, and the products of mean encounter rate and commercial effort were summed across remaining depth-grids and compared to the baseline to determine the relative potential encounter risk remaining. As many area-depth grids were only partially contained by spatial closure alternatives, weighted mean encounter rates and effort were recomputed for each alternative. Effort was multiplied by the ratio of the percent of area remaining to the total area of the area-depth grid.

Cumulative Effects

To evaluate the cumulative effects of spatial closure alternatives upon landings and relative right whale entanglement risk, daily catch rates were forward-projected in Microsoft Excel for a future Jan-Dec fishing season. This analysis was performed for spatial distribution scenarios A-C and catch rate scenarios 1-4 for all eight Reg-16 alternatives. Additionally, two sensitivity runs were performed for a warm and cold winter distribution of right whales. Cumulative relative right whale risk was tracked under each scenario-alternative combination from Jan 1-Apr 30 and Nov 1-Dec 31, or the season closure date (whichever came sooner). Total catch relative to the ACL, closure date and total days open, and cumulative relative right whale risk were all output from the model. Total landings and season length were compared to Alternative 1 (status quo). Because the entanglement rate for North Atlantic right whales is unknown, risk was expressed as relative risk units (RRU). Daily relative right whale risk units were scaled from 0 RRU (Alternative 1: EEZ closed Nov-Apr) to 100 RRU (no closed area). Under all scenarios, daily relative right whale risk is eliminated when a quota closure is imposed to avoid an ACL overage, because the fishery would be closed to all gears. Daily relative right whale risk might exceed 100 RRU under scenarios where the proposed closed area slows catch rates enough for the fishery to stay open later than it would with no closed area to pot gear but fails to sufficiently mitigate right whale risk during the additional days open. Risk levels were categorized to facilitate distinction between alternatives (Low <25 RRU, Moderate 26-50, High 51-75, Very High >75). Right whale risk for the FL-SC and NC models was handled separately due to differences in model construction. A sensitivity run incorporating a dynamic monthly model of whale distributions off NC was performed (Appendix E). To evaluate whether the differences between alternatives were significant, within-model uncertainty was evaluated using modeled 95% confidence limits (Appendix F).

Impacts on other Large Whales

Other species of large whales protected under the Marine Mammal Protection Act are periodically observed by the SEUS Survey and UNCW Survey, including humpback whales (*Megaptera novaeangliae*) and fin whales (*Balaenoptera physalus*). Sightings of these large whales were plotted relative to proposed closed areas to determine if proposed closed areas might provide potential reductions in entanglement risk for large whales other than right whales.

RESULTS

Spatial Distribution of Landings and Effort

From 2004/05-2008/09, pot gear effort during months completely open to pot gear fishing averaged 2126 ± 1410 pots/month (mean ± SD), with an average of 3038 ± 1219 pots/month from Nov-Apr. Since the implementation of Amendment 18A, the 32 pot gear endorsement holders have averaged 2122 ± 653 pots/month (range 1503-3148 pots/month) during months completely open to pot gear fishing. In the 2013/14 season, number of pots per trip averaged 24.9 ± 9.7, with 52.3 ± 36.4 hauls per trip. Trips averaged 1.4 ± 0.6 days. Soaktimes averaged 4.4 ± 4.0 hours per trap (range 0.33-28.0 hours). Total soaktime per trip averaged 245.8 ± 337.6 hours (range 5.3-5040.0 hours).

Commercial black sea bass pot endorsement holders tended to fish between 15-40 m depth (Figure 1). Analyses of seasonal fishing trends indicated little overall trend in reported depth of fishing using pot gear for black sea bass for Florida and North Carolina, but an inshore movement of the fishery during winter months was apparent for South Carolina (Figure 2). A comparison of Nov-May pot gear endorsement holder landings from the 2008/09 season (Scenario A) to June-Oct pot gear endorsement holder landings from the 2013/14 (Scenario B) showed higher proportional landings off SC under Scenario A, and higher proportional landings off NC and FL under Scenario B (Figure 3). Landings and effort in the 2008/09 winter months covered a narrower geographic range than the 2013/14 summer season (Figure 3). In the 2008/09 winter months, fishing activity shifted from nearshore NC (Nov-Dec: Figures 3A-B) to South Carolina (Dec-Feb: Figures 3B-D) and then farther offshore of both NC and SC (Feb-Apr: Figures 3D-F). This spatial shifting was not observed in Scenario B due to the static treatment of the summer 2013/14 landings and effort data (Figure 3G). The spatial extent of landings and effort under Scenario C (Figures 3H-M) was similar to Scenario A; however, landings and effort averaged across the three winters were more diffuse with fewer obvious 'hot-spots.'

Catch Rate Projections

Between 2006/07 and 2013/14, black sea bass catch-per-trip for endorsement holders was within 50 pounds of the 1000-lb gw trip limit on average 24% of trips, with a peak of 56% in 2011/12 and a minimum of 10% in the most recent 2013/14 season. Catch-per-pot haul in the commercial black sea bass fishery was historically higher during the winter months, but this trend shifted towards the summer months as derby conditions emerged (Figure 4). Daily catch rates for projection Scenarios 1-4 are presented in Table 1. Winter catch rates were highest under Scenario 2 and lowest under Scenario 3. Scenarios 1, 2, and 4 showed a dome-shaped catch rate with peaks in Dec-Feb (Figure 5). The abundance of black sea bass vulnerable to pot gears has nearly doubled since the 2008/09 season (Figure 6).

Right Whale Spatial Distribution Model

Wintering habitat models were developed to predict right whale distribution for FL-SC (Gowan and Ortega-Ortiz 2014) and NC (Gowan, unpublished data) over time. The FL-SC model predicts a seasonal trend in right whale distribution (Figure 7). In December and March (Figures 7A and 7D), the model predicts right whales to be distributed farther north than in January and February (Figures 7B and 7C). The data informing the NC model were not sufficiently robust to construct monthly models of right whale abundance; however, the model predicted right whales might be sighted across a relatively broad area, with the highest encounter rates relatively close to the NC shoreline and off Pamlico Sound. As illustrated in Appendix D, under the 'warm' winter scenario, the distribution compressed closer to shore, in the relatively shallow, cooler waters west of the Gulf Stream; under the 'cold' winter scenario, the distribution was more concentrated farther south (Gowan and Ortega-Ortiz 2014).

Relative Risk of Right Whale Entanglement in Pot Gear Vertical Lines

Figure 8 shows effort-weighted relative right whale risk of interactions with pot gear vertical lines under gear distribution Scenarios A (pot gear distribution based on observed 2008/09 winter deployments) and B (pot gear distribution based on observed 2013/14 summer deployments). Because the NC right whale distribution model and the pot distribution in Scenario B are not time-dynamic, modeled risk of NC for Scenario B did not vary by month. For Scenario B, from Nov-Apr, right whale weighted entanglement risk was highest between 5-30 m between Wilmington and Jacksonville (Figures 8A-F).

In November (Figure 8A), weighted entanglement risk for right whales in FL-SC was highest off Murrell's Inlet, South Carolina and Daytona Beach, Florida under Scenario A; risk off NC was highest between 5-30 m from Jacksonville to Wilmington, North Carolina. Under Scenario B, weighted entanglement risk in FL-SC was highest off Charleston, South Carolina, followed by Murrell's Inlet, South Carolina, and Daytona Beach, Florida; off NC, risk was slightly higher offshore of Jacksonville than in Scenario A (Figure 8A). In December, under both Scenarios, weighted risk was highest off Charleston, South Carolina; followed by Murrell's Inlet, South Carolina, and Daytona Beach, Florida (Figure 8B). In December, off North Carolina, under both Scenarios, weighted risk was highest from Wilmington to Jacksonville in waters <30 m. From January-February, under both Scenarios, weighted risk was highest off Charleston, South Carolina and Daytona Beach, Florida; followed by Murrell's Inlet, South Carolina (Figures 8C-D). In January-February off North Carolina, Scenario A shows much more broadly distributed relative risk than Scenario B (Figures 8C-D). From March-April, under Scenario A, weighted risk was highest off Murrell's Inlet, South Carolina and, in April, Daytona Beach, Florida (Figure 8E-F). Under Scenario B, weighted risk was highest off Charleston, South Carolina; followed by Murrell's Inlet, South Carolina, and Daytona Beach, Florida. In March-April, Scenario A predicts much more broadly distributed relative risk off North Carolina than Scenario B (Figure 8E-F). In general, black sea bass fishing pressure and associated right whale entanglement risk off Florida to South Carolina are more broadly distributed under Scenario B, and more broadly distributed off North Carolina under Scenario A. Because pot distribution under Scenario C was similar to that under Scenario A, it was not depicted in Figure 8.

Cumulative Effects

Different catch rate and closure scenarios resulted in different projected closure dates for the commercial black sea bass fishery to avoid an ACL overage (Figure 9). Table 2 and Figure 10 show the interplay of projected black sea bass fishing season lengths and cumulative relative risk of right whales to entanglement in vertical lines associated with black sea bass pot gear. Under all alternatives except Alternative 1 (status quo) and a few scenarios for Alternatives 7b, 8b, 9b, and 10, a quota closure was anticipated to avoid a quota overage. A quota closure would reduce relative right whale risk by reducing the number of days pot gear is in the water.

Under warmer than average conditions, the predicted right whale distribution was located closer to shore and most depth-based spatial closure alternatives are more effective in reducing relative risk of entanglement (Table 2B). Some permutations suggested Alternative 7B could be less effective even than opening the entire EEZ to pot gear fishing Nov-Apr under warmer than average conditions because it would allow two additional months of fishing during right whale season. Under colder than average conditions, the predicted right whale distribution was farther south and more broadly distributed offshore, making most depth-based closure Alternatives less effective than under average conditions (Table 2C). A sensitivity run using monthly SST data to generate monthly predictions of right whale abundance off NC found minimal differences compared to the time-averaged model approach presented in Table 2 (see Appendix E).

Table 3 shows relative risk of right whale entanglement ranked by alternative, ranging from Alternative 1 (most protective) to Alternative 2 (least protective). Figure 11 shows the clustering of sensitivity run output by alternatives for relative right whale risk and fishing season length. Alternatives 4 and 6 provide the least additional right whale risk of any pot gear opening under consideration (Table 3), while also providing the longest fishing seasons (Figure 11). Alternatives 2, 7a, and 7b provide similarly high relative right whale risk and shorter seasons than the other alternatives (Figure 11). Within-model uncertainty was relatively low, and the separation between the most protective and least protective alternatives was significant (see Appendix F).

Under Alternative 1, no quota closure was projected. Alternative 1 was projected to catch 97% of the ACL while maintaining the six-month seasonal closure to pot gear fishing and providing no increased risk of vertical line entanglement for right whales. Under Alternative 2, a quota closure date was projected for 4 Aug-2 Oct. Alternative 2 increases relative right whale risk by 100 RRU over status quo. Under Alternative 3, a quota closure date was projected for 4 Oct-5 Dec. Alternative 3 results in a low to moderate increase in relative right whale risk off NC (+10-26 RRU) and a low to high increase in relative right whale risk off FL-SC (+16-52 RRU). Under Alternative 4, a quota closure date was projected for 7-30 Dec. Alternative 4 results in a low increase in relative right whale risk off NC (+2-8 RRU) and a low increase in relative right whale risk off FL-SC (+0-3 RRU). Under Alternative 5, a quota closure date was projected for 1-24 Dec. Alternative 5 results in a low increase in relative right whale risk off NC (+1-2 RRU) and a low to high increase in relative right whale risk off FL-SC (+11-58 RRU). Under Alternative 6, a quota closure date was projected for 7-29 Dec. Alternative 6 results in a low increase in relative right whale risk off NC (+2-8 RRU) and no additional right whale risk off FL-SC (0 RRU). Under Alternative 7a, a quota closure was projected for 18 Aug-12 Oct. Alternative 7a results in a high increase in relative right whale risk off NC (+69-74 RRU) and very high increase in relative right whale risk off FL-SC (+77-96 RRU). Under Alternative 7b, the ACL was projected to be met between 17-30 Dec. Alternative 7b results in a very high increase in relative right whale risk off NC (+77-89 RRU) and a high to very high increase in relative right whale risk off FL-SC (+70-106

RRU). Under Alternative 8a, a quota closure was projected for 17 Oct-11 Dec. Alternative 8a results in a low to moderate increase in relative right whale risk off NC (+13-36 RRU) and a low to high increase in relative right whale risk off FL-SC (+13-64 RRU). Under Alternative 8b, the ACL was projected to be met late in the fishing season (18 Dec or later). Alternative 8b results in a high increase in relative risk off NC (+51-68 RRU) and a high to very high increase in relative risk off FL-SC (+61-89 RRU). Under Alternative 9a, a quota closure was projected for 15 Sept-9 Nov. Alternative 9a results in a moderate increase in relative right whale risk off NC (+26-51 RRU) and moderate to high increase in relative right whale risk off FL-SC (+30-72 RRU). Under Alternative 9b, the ACL was projected to be met as early as 14 Dec. Alternative 9b results in a high to very high increase in relative right whale risk off NC (+61-87 RRU) and high to very high increase in relative right whale risk off FL-SC (+67-94 RRU). Alternative 10 falls between Alternatives 8b and 9b, with a projected closure date as early as 16 Dec, a moderate to high increase in relative right whale risk off NC (+55-75 RRU) and high to very high increase in relative right whale risk off FL-SC (+62-89 RRU).

Impacts on other Large Whales

Maps of aerial survey observations confirmed the presence of humpback whales and fin whales within several of the proposed Reg-16 closure areas (Figure 12). From 2005-2014, a total of 135 humpback whale sightings were recorded by the two surveys, of which six were confirmed dead. A total of 21 fin whales were also recorded. Number of observations was highest in areas of highest survey effort. Some of these sightings may represent multiple sightings of the same individual.

DISCUSSION

During the 2013/14 season, SEFSC in-season quota monitoring projected 99.6% of the ACL was caught with no pot gear fishing during the Nov-Apr period. Analyses of Reg-16 alternatives indicated that nearly all scenarios would result in the ACL being achieved. These analyses are based heavily upon data from the recent 2013/14 season because the black sea bass commercial fishery is in a dynamic state. Trends in catch per pot haul (see Figure 4) reveal a full-season fishery with peak catches in winter during the first part of the past decade that shifted to a derby fishery in the past 5 years, characterized by high summer catch rates and early quota closures. The 2008/09 season was the last season with no quota closure during right whale season (Nov 1-Apr 30). Despite effort restrictions implemented under Amendment 18A and the substantial increase in ACL implemented by Reg-19, the commercial fishery caught over 99% of their ACL during the 2013/14 season. Even with the hook-and-line gear trip limits imposed by Reg-14, they are projected to catch 97% of their ACL under Alternative 1 for the 2014/15 season. The derby condition may have relaxed somewhat, as landings in 2012/13 and 2013/14 were more evenly distributed through the fishing season; however, it is too early to definitively state that the derby conditions have ended. Furthermore, the implementation of Reg-14 will shift the season start date from June 1 to Jan 1, guaranteeing at least some pot gear fishing during the Nov 1-Apr 30 right whale season with the implementation of any alternative under Reg-16, excluding the no action alternative. The pot endorsement requirement implemented by Amendment 18A substantially reduced participation in the pot gear fishery, which historically has shown higher daily catch rates than other gears. Because participation is limited and the ACL has been substantially increased, the incentives for derby fishing have diminished, and may be further diminished by communication between fishermen. The reduction in pot gear fishery participation has been partially offset by increases in the number of participants using other gears. During the 2013/14 season, 68% of the commercial harvest originated from gears other than pots, as compared to an average of 28% from 2004-2013.

Given the substantial changes in the fishery in the last two fishing seasons and the lack of fishing (due to quota closures) in the Nov-Apr time period of greatest concern for federally-protected large whale species, it is challenging to predict the impacts of the various Alternatives under consideration by Reg-16. To encompass the range of realistic possibilities, four scenarios were evaluated for catch rate, and three scenarios were evaluated for the spatial distribution of fishing. Projected closure dates for each alternative across scenarios varied by as much as 59 days; however, the relative differences between alternatives were consistent across scenarios. Catch rate projection Scenario 1 does not account for the rebuilding of the black sea bass stock, because it is based on 2008/09 catch rates, but it does feature winter catch rates on par with those observed in summer months during the 2013/14 season. Scenario 2 does not account for a potential decline in catch rate during winter months due to high pressure during summer months, which would likely result in localized depletion. The catch rates predicted by Scenario 2 have been observed in a single month in previous seasons, but never in multiple consecutive months as predicted. The sum of anticipated pot catches across the season in Scenario 2 exceeds the highest observed catches for every month by 5%; however, the abundance of black sea bass available to the pot gear fishery is projected to be substantially higher than observed since pre-1998 (Figure 6), and the reconfiguration of the commercial season to Jan-Dec by Reg-14 increases the likelihood of high Jan-Apr catch rates and reduces concerns about the impacts of localized depletion on projected catch rates in the first few months of the season. In summary, Scenario 2 may capture this increasing abundance trend, or it may overestimate catch rates that could be achieved in future seasons. Scenario 3 maintains a constant Oct 2013/14 catch rate through Nov-May; as such, it does not account for any temporal dynamics of catch rate which might be caused by fish movement or adverse weather conditions reducing the number of potential trips that could be taken. Scenario 4 accounts for potential impacts of the economic crash and high fuel prices in 2008/09 by averaging catch rates across the last three open winter seasons (2006/07-2008/09).

Of the spatial closure scenarios evaluated, Scenarios A and C do not account for recent shifts in the core distribution of fishing pressure. The stock may have shifted in regional abundance to localized recruitment pulses or localized depletion, and some pot gear endorsement holders may have moved or dropped out of the fishery since past winter seasons. Similarly, Scenario B does not account for inshore/offshore dynamics for winter months, because it is based on 2013/14 data from June-Oct. Off South Carolina, there are some indications of an inshore shift in fishing pressure during the winter months; however, from a statistical standpoint, this shift was insignificant based on the reported depth of fishing. If there is a shift in fishing depths during winter months, this would not be captured by Scenario B. Accurately predicting the impacts of spatial closures is further challenged because area and depth of fishing are reported at the trip level. Multiple sets may be made during a single trip; therefore, there may be depths and areas fished that are not accurately represented in the logbook. This is less of a concern with commercial black sea bass pot gear than for many other fisheries due to the relatively low trip limit constraining the number of sets that might be made during a single trip. The model assumes landings during May-Oct will proceed equivalent to 2013/14 observations. Reduced catch rates prior to Nov would result in longer winter seasons for all scenario-alternative combinations with projected quota closures, leading to increased cumulative relative right whale risk.

Removing the closed area for pot gear would provide the fastest path towards achieving the ACL, as it removes all spatiotemporal restrictions on the use of pot gear to harvest black sea bass. Reg-16 Alternative 2 has minimal spatial overlap with black sea bass pot fishing effort, and results in nearly identical outcomes to removing the closed area entirely with regards to landings achieved. The spatial overlap of black sea bass fishing effort with the proposed closed areas in Alternatives 4 and 6 is robust to the assumed distribution of fishing pressure. By contrast, the spatial overlap of black sea bass fishing effort with the proposed closed areas in Alternatives 3, 5, 7a, 8a, and 9a is more dependent upon assumptions about the spatial distribution of fishing pressure.

The Alternatives proposed in Reg-16 differ in their abilities to maintain protections (i.e. prevent or minimize an increase in relative risk of entanglement) for ESA-listed whales in the South Atlantic Region. All alternatives, excluding Alternative 1 (the No Action Alternative), result in an increase in relative risk of entanglement to right whales. Alternative 1 best maintains protections for ESA-listed whales in the South Atlantic region because it maintains the seasonal closure to pot gear fishing, resulting in no increased risk of vertical line entanglement for large whales from black sea bass pot gear. Conversely, removing the closed area entirely would fail to maintain protections for ESA-listed whale species because it would eliminate the seasonal closure to pot gear fishing implemented to protect endangered large whales from entanglement in black sea bass pot gear, exposing right whales to the maximum possible daily vertical line entanglement risk (i.e., 100% on the relative scale described in the Methods).

Alternatives 2, 7b, 7c, 9b, and 8b maintain little to no protection for ESA-listed whales in the South Atlantic Region. Alternative 2 greatly increases the relative risk of entanglement to right whales off North Carolina and between Florida and South Carolina. Alternative 2 represents the current North Atlantic right whale critical habitat designated for North Atlantic right whales in 1994. This area was originally based on 303 sightings from 1950-1989. However, North Atlantic right whale critical habitat is currently undergoing a revision based on more current data. Proposed changes were published 17 Feb 2015 at [80 FR 9313](). The very high relative risk associated with Alternative 2 is because predicted right whale presence is high outside of the spatial boundaries of the Alternative 2 management area (i.e., the area proposed in Alternative 2 is insufficient to protect right whales from an increase in relative risk of entanglement). Alternatives 7b, 7c, 8b, and 9b greatly increase the relative risk of right whale entanglement over the status quo for temporal (does not account for year-round presence of right whales off

North and South Carolina) and spatial reasons (does not account for spatial use of right whales off Florida). Alternative 7a, 8a, and 9a are slightly more protective because they prohibit pot gear fishing for more of the right whale season across a broader geographic range.

Alternative 3 would result in a low to moderate increase in relative risk to right whales from potential entanglement off North Carolina and a moderate to high increase in relative risk between Florida and South Carolina. This increase in relative risk is likely because the area proposed in Alternative 3 is based on habitat features preferred by pregnant female right whales and mother/calf pairs only (Good 2008, Keller et al. 2012), and does not consider juveniles, non-reproducing adults, or account for the north/south migratory behavior of right whales (i.e. whales may occur outside of predicted areas due to behavioral reasons). Juvenile right whales are a particularly important demographic segment to consider since they are most prone to entanglement (Knowlton et al. 2012).

Of all the alternatives in Reg-16, Alternatives 4 and 6 result in the least increase in relative risk to right whales, followed by Alternative 5. Alternative 4 is based on 2005/06-2012/13 right whale Early Warning System (EWS) and South Carolina/Georgia aerial survey data and 2001/02, 2005/06, and 2006/07 surveys by the University of North Carolina-Wilmington (Garrison 2014). This is a more expansive and recent database than that used by Keller et al. (2012) and particularly is more robust off the state of South Carolina. Alternative 4 includes all right whale demographic segments (i.e., mother/calf pairs, pregnant females, non-reproducing females, adult males, and juveniles). The area in this alternative captures 97% and 96% of right whale sightings in the NC/SC region and the FL/GA region, respectively.

Alternative 5 results in a low increase in relative risk off North Carolina but a greater increase in relative risk from Florida to South Carolina. In particular, the increase in relative risk from Florida to South Carolina is the result of estimated commercial pot gear effort south and east of the proposed area from St. Augustine to Cape Canaveral, Florida. Alternative 5 is based on joint comments received from non-government organizations (dated January 3, 2014) in response to NMFS' December 4, 2013, *Federal Register* Notice of Intent to Prepare this Draft Environmental Impact Statement (DEIS) (78 FR 72868). The area, also included in a Center for Biological Diversity et al. petition in 2009 for right whale critical habitat, is off the coasts of Georgia and Florida and based on calving right whale habitat modeling work of Garrison (2007) and Keller et al. (2012). This area represents the 75th percentile of right whale sightings (91% of historical sightings included in their study) off Florida and Georgia (Garrison 2007, and Keller et al. 2012). This alternative provides less protection in the core calving area because the protected area likely does not extend far enough into South Florida waters to capture the full extent of right whale habitat usage.

Alternative 6 would result in a low increase in relative risk to whales off North Carolina and no additional entanglement risk to right whales off Florida to South Carolina. The Alternative 6 area extends substantially further offshore of Florida and Georgia than areas included in other alternatives. Consequently, similar to Alternative 1, Alternative 6 would result in no increase in relative risk to right whales off Florida and Georgia and, arguably, negligible increase in relative risk off South Carolina. Alternative 6 is also based on joint comments received from a number of environmental groups (dated January 3, 2014) in response to NMFS's December 4, 2013, *Federal Register* Notice of Intent (78 FR 72868). This area represents an existing management area, the Southeast Seasonal Gillnet Restricted Area, under the ALWTRP; and an additional area off North Carolina. The area off North Carolina is northward of the designated ALWTRP Southeast Restricted Area and includes waters shallower than 30 m. Overall, aside from Alternative 1, Alternative 6 results in the least amount of increase in relative risk to right whales from entanglement.

There is uncertainty in the predicted distribution of right whales, especially off North Carolina, where limited data with relatively few sightings were available. However, limited data should not be confused with limited right whale use of the area. Both the FL-SC and NC models implicitly assume that detectability of right whales (and therefore number of sightings) is equivalent across the spatial domain; however, it is widely accepted that detectability can vary. Richardson et al. (1995) found migrating bowhead whales (closely related to right whales) spent an especially low percentage of time at the surface and reasoned that the low percent of surface time explained low sightability of bowheads during aerial surveys of migrating whales. Likewise, the mid-Atlantic is used by right whales as a migratory corridor, among other uses, including calving grounds. Some of the more common behaviors off North and South Carolina may lead to right whale presence being underestimated by visual detection surveys. Additionally, the model was constructed based on right whale distribution on their primary wintering grounds not in their migratory corridor. Due to a lack of survey data, December distributions were used to represent November, and March model distributions were used to represent April. There may be differences between modeled distribution and actual distribution during these periods. Preliminary data demonstrate that the majority of right whales that frequent the calving area are present there for only a period of a few weeks (A. Krzystan, June 2014 SEIT meeting). As many as 243 right whales have been sighted in the Southeast U.S. wintering habitat in one winter. If most of these whales were present for a period of weeks and other whales are short-stopping off South and North Carolina, there is likely a steady, constant presence of right whales in the mid-Atlantic during the Nov-Apr period.

The modeled distribution used in this report averages across years with relatively low and high sighting frequency. It is unlikely this averaging would have a substantial impact upon the projected relative risk associated with each spatial closure alternative. Additionally, the modelling approach described in this report uses the overlay of black sea bass pot gear fishing effort (expressed in line-hours) and predicted right whale distribution to determine right whale relative risk of entanglement. This is a frequently used approach in whale risk assessment (Vanderlaan *et al.* 2009, Williams & O'Hara 2010, Murray & Orphanides 2013, Brown *et al.* 2015), because estimation of absolute risk is often impractical (Fonnesbeck *et al.* 2008, Redfern *et al.* 2013). This approach implicitly assumes that right whale entanglement rates do not vary by gender, size, space or time; however, certain behaviors or size classes of whales in certain locations at certain times might be more inherently vulnerable to entanglement than others (Knowlton *et al.* 2012). A sensitivity run using right whale distributions under warmer than average conditions showed most spatial closures would be more effective if the right whale distribution is compressed close to shore. Under colder than average conditions, most proposed closure alternatives become less effective, because the right whale population is located farther south and more broadly distributed offshore beyond the closure boundaries. Alternatives 4 and 6 both provided very little additional entanglement risk to right whales off Florida to South Carolina under all sensitivity runs. Insufficient data were available to explore the impacts of warmer or colder than average conditions on right whale distributions off North Carolina, and no assumptions were made regarding the redistribution of the black sea bass population or associated fishing effort under these different temperature regimes. Average temperature conditions are more appropriate for forecasting risk when future temperature conditions are unknown.

The modeling approach did not assume an inherent rate of right whale entanglement relative to vertical line hours. Instead, all comparisons were made relative to the cumulative right whale risk assuming no closed area within each spatial distribution and catch rate scenario. Because all comparisons were performed in a relative framework, potential differences in the magnitude of exposure to risk between scenarios are not possible, nor would they be appropriate given that each scenario operates independently. For example, it would not be appropriate to compare the total exposure to risk assuming a summer distribution of pot gear in Alternative 2 to the total exposure to risk assuming a winter distribution of pot gear in Alternative 4. Although we were constrained by available data to apply 2013/14 mean pot soak times to historical spatial distributions of pot gear, this scalar is washed out by the relative framework of comparison. Thus, if winter wind and sea state conditions are such that shorter soak times are used, shorter soak times would reduce the total magnitude of right whale risk for each alternative, but the impact on relative comparisons would be dampened and only have an impact when an Alternative allowed fishing longer into the winter season than having no closed area. In this instance, the projected relative risk under the closure alternative with more time fishing under shorter soak times would be less than projected in this report.

The analysis does not consider the potential for effort shifting into open areas during the Nov-Apr time period. Few of the areas that would remain open have been fished for black sea bass, and most of them have not been fished in the Nov-Apr time period for five years or more. As such, it is difficult to determine how much effort might shift to open areas, which open areas would receive new effort, whether fishing opportunities exist in areas outside the closure, and what catch rates might be in those areas. Although estimating the impacts of effort shifting is challenging, the directional impacts of any effort shifting are relatively easy to describe. If effort shifting into open areas occurs, the projections may underestimate the potential catch rates of black sea bass if deeper portions of the stock can be caught outside the closed areas. The fuel costs associated with reaching open areas farther offshore combined with the requirement to bring pot gear back to shore under a 1000-lb gw trip limit might serve as a financial disincentive for commercial pot fishers to shift effort into deeper water offshore. If effort shifting takes place, quota closures would take place sooner than projected in this report. Relative entanglement risk for right whales in open areas would increase if effort shifted into those areas, although for some closure alternatives the areas of highest risk would be closed and effort would shift into low risk areas. Additionally, some right whale risk might be offset by reductions in season length due to earlier ACL quota closures. This is likely to apply only to the Nov 1-Dec 31 period following implementation of Reg-14. Alternative 3 provides greater opportunities for effort shifting offshore of Daytona Beach and Charleston than Alternatives 4-6; as such, the relative risk under Alternative 3 may be higher than estimated in Table 2.

Aerial survey observations indicate humpback whales and fin whales are found within areas historically used by the black sea bass pot gear fishery. As such, they may also be at risk of entanglement and may be impacted by alternatives being considered by Reg-16. The federally-protected North Atlantic humpback whale is assumed to use the mid-Atlantic as a migratory pathway to and from their calving/mating grounds in the West Indies. Furthermore, biologists theorize that non-reproductive humpbacks may be establishing a winter feeding range in the mid-Atlantic since they are not participating in reproductive behavior in the Caribbean (Barco *et al.* 2002). As with right whales, a major known source of human-caused mortality and injury of humpback whales is commercial fishing gear entanglements. Sixty percent of closely investigated mid-Atlantic humpback whale mortalities showed signs of entanglement or vessel collision (Wiley *et al.* 1995). A scar-based study of Gulf of Maine humpback whales indicated that over half of the population had experienced a previous entanglement, and 8-25% received new injuries each year (Robbins and Mattila 2004). From 2006 through 2010, there were at least 29 serious injuries and mortalities attributed to entanglement for humpback whales (Waring et al. 2014). The impacts of Reg-16 alternatives for other large whales such as humpback whales and fin whales could not be quantified due to a lack of detailed mid-Atlantic distribution data.

In summary, the lack of recent winter fishing challenges predicting future fisher behavior, and the unknown dynamics of serial depletion make it challenging to predict future black sea bass catch rates, especially in the Nov-Apr time period. Our analyses provide a broad range of possible scenarios to highlight the uncertainty in predicted catch rates. Analyses indicated that proposed pot gear closed areas do not cover all reported historical pot gear fishing grounds and cover varying proportions of areas where right whales are predicted to be found. Increased fishing pressure early in the season similar to derby conditions observed in the past, pot gear effort shifting into deeper water outside a closed area, removing the hook and line gear trip limit, and allowing additional pot gear participation could all increase the probability of attaining the ACL sooner than projected.

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Table 1. Estimated daily catch rates (lb gw) for Scenario 1 (observed 2008/09), Scenario 2 (monthly ratio 2008/09 applied to 2013/14 Oct catch rate), Scenario 3 (constant Oct 2013/14 catch rate), and Scenario 4 (mean observed 2006/07-2008/09) by fishing month.

Month	Status Quo	Scenario 1	Scenario 2	Scenario 3	Scenario 4	"Other Gear"
Jan	0	1,866	3,351	1,214	2,013	875
Feb	0	1,669	2,998	1,214	1,633	1,535
Mar	0	1,051	1,888	1,214	1,196	628
Apr	0	384	690	1,214	1,229	903
May	0	315	566	1,214	1,214	1,028
June	2,013	2,013	2,013	2,013	1,146	2,007
July	1,633	1,633	1,633	1,633	2,092	1,547
Aug	1,196	1,196	1,196	1,196	1,791	1,027
Sept	1,229	1,229	1,229	1,229	2,046	842
Oct	1,214	1,214	1,214	1,214	1,108	733
Nov	0	1,266	2,274	1,214	548	193
Dec	0	1,384	2,485	1,214	207	2,381

Table 2. Projected commercial black sea bass closure dates, percent of ACL reached, and risk of right whale entanglement in pot gear vertical lines (in relative risk units) under proposed Alternatives in Regulatory Amendment 16.

MEAN CONDITION		Alt1	No Closure				Alt2				Alt3				Alt4				Alt5				Alt6				Alt7a			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/5	10/12	10/28	12/3	12/30	12/22	12/18	12/30	12/24	12/11	12/11	12/23	12/29	12/21	12/18	12/29	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	14	10	10	14	2	2	2	2	2	2	2	2	2	2	2	2	74	74	74	74
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	48	47	47	48	0	0	0	0	37	37	37	37	0	0	0	0	94	94	94	94
Scenario B	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/3	10/17	11/4	12/2	12/28	12/19	12/18	12/29	12/18	12/2	12/8	12/17	n/a	12/25	12/20	n/a	10/12	8/20	10/9	10/9
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	26	21	21	26	8	8	8	8	2	1	1	2	8	8	8	8	69	69	69	69
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	30	29	29	30	2	2	2	2	43	42	42	43	0	0	0	0	77	77	77	77
Scenario C	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	11/26	10/4	10/26	11/19	12/20	12/7	12/11	12/19	12/16	12/1	12/6	12/15	12/20	12/7	12/10	12/19	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	17	13	13	16	4	3	3	3	2	2	2	2	4	3	3	3	71	71	71	71
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	44	43	43	44	1	1	1	1	34	33	33	34	0	0	0	0	84	84	84	84

MEAN CONDITION		Alt1	Alt7b				Alt7c				Alt8a				Alt8b				Alt9a				Alt9b				Alt10			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	n/a	12/30	12/21	n/a	12/28	12/17	12/14	12/29	12/11	10/24	10/31	12/9	n/a	12/30	12/21	n/a	10/31	9/20	10/15	10/27	n/a	12/28	12/20	n/a	n/a	12/29	12/20	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	98%	100%	100%	100%	100%	99%	100%	100%	99%	99%	100%	100%	99%
	RW Risk (NC)	0	81	80	77	81	80	76	75	81	14	13	13	14	55	54	51	55	26	26	26	26	65	64	61	65	59	58	55	59
	RW Risk (FL-SC)	0	98	97	92	98	91	85	83	92	40	38	38	39	81	79	74	81	62	62	62	62	90	87	83	90	81	79	74	81
Scenario B	Closure Date	n/a	12/28	12/18	12/17	12/28	12/22	12/9	12/11	12/23	12/7	10/25	11/5	12/6	12/29	12/20	12/18	12/29	11/9	9/27	10/19	11/3	12/26	12/15	12/14	12/26	12/27	12/17	12/16	12/28
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	86	78	77	86	92	82	83	93	36	30	31	36	68	61	59	68	51	48	48	49	87	78	78	87	74	66	65	75
	RW Risk (FL-SC)	0	73	70	70	73	70	67	67	71	50	48	49	50	65	62	61	65	57	56	56	56	71	68	68	71	65	62	62	66
Scenario C	Closure Date	n/a	n/a	12/27	12/19	n/a	12/27	12/16	12/13	12/28	12/6	10/17	10/29	12/5	n/a	12/28	12/20	n/a	10/28	9/15	10/13	10/24	12/31	12/24	12/17	n/a	n/a	12/25	12/18	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
	RW Risk (NC)	0	89	84	77	89	96	86	83	97	19	17	17	19	65	60	53	65	35	35	35	35	82	77	70	82	71	71	71	71
	RW Risk (FL-SC)	0	92	89	84	92	85	78	76	86	37	36	36	37	76	74	68	76	56	56	56	56	84	79	74	84	77	72	68	77

WARM CONDITION		Alt1	No Closure				Alt2				Alt3				Alt4				Alt5				Alt6				Alt7a			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/5	10/12	10/28	12/3	12/30	12/22	12/18	12/30	12/24	12/11	12/11	12/23	12/29	12/21	12/18	12/29	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	14	10	10	14	2	2	2	2	2	2	2	2	2	2	2	2	74	74	74	74
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	33	32	32	33	0	0	0	0	13	12	12	13	0	0	0	0	96	96	96	96
Scenario B	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/3	10/17	11/4	12/2	12/28	12/19	12/18	12/29	12/18	12/2	12/8	12/17	n/a	12/25	12/20	n/a	10/12	8/20	10/9	10/9
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	26	21	21	26	8	8	8	8	2	1	1	2	8	8	8	8	69	69	69	69
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	17	16	16	17	1	1	1	1	15	15	15	15	0	0	0	0	82	82	82	82
Scenario C	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	11/26	10/4	10/26	11/19	12/20	12/7	12/11	12/19	12/16	12/1	12/6	12/15	12/20	12/7	12/10	12/19	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	17	13	13	16	4	3	3	3	2	2	2	2	4	3	3	3	71	71	71	71
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	31	30	30	31	0	0	0	0	11	11	11	11	0	0	0	0	91	91	91	91

WARM CONDITION		Alt1	Alt7b				Alt7c				Alt8a				Alt8b				Alt9a				Alt9b				Alt10			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	n/a	12/30	12/21	n/a	12/28	12/17	12/14	12/29	12/11	10/24	10/31	12/9	n/a	12/30	12/21	n/a	10/31	9/20	10/15	10/27	n/a	12/28	12/20	n/a	n/a	12/29	12/20	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	98%	100%	100%	100%	100%	99%	100%	100%	99%	99%	100%	100%	99%
	RW Risk (NC)	0	81	80	77	81	80	76	75	81	14	13	13	14	55	54	51	55	26	26	26	26	65	64	61	65	59	58	55	59
	RW Risk (FL-SC)	0	106	105	99	106	96	89	87	97	14	13	13	14	84	83	77	84	46	46	46	46	90	88	82	90	84	82	77	84
Scenario B	Closure Date	n/a	12/28	12/18	12/17	12/28	12/22	12/9	12/11	12/23	12/7	10/25	11/5	12/6	12/29	12/20	12/18	12/29	11/9	9/27	10/19	11/3	12/26	12/15	12/14	12/26	12/27	12/17	12/16	12/28
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	86	78	77	86	92	82	83	93	36	30	31	36	68	61	59	68	51	48	48	49	87	78	78	87	74	66	65	75
	RW Risk (FL-SC)	0	84	80	80	84	82	77	78	83	22	21	21	22	68	64	63	68	31	30	30	30	72	67	67	72	68	64	64	69
Scenario C	Closure Date	n/a	n/a	12/27	12/19	n/a	12/27	12/16	12/13	12/28	12/6	10/17	10/29	12/5	n/a	12/28	12/20	n/a	10/28	9/15	10/13	10/24	12/31	12/24	12/17	n/a	n/a	12/25	12/18	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
	RW Risk (NC)	0	89	84	77	89	96	86	83	97	19	17	17	19	65	60	53	65	35	35	35	35	82	77	70	82	71	71	71	71
	RW Risk (FL-SC)	0	103	99	92	103	99	91	88	100	14	13	13	14	89	86	79	89	41	41	41	41	93	87	82	94	89	84	78	89

COLD CONDITION		Alt1	No Closure				Alt2				Alt3				Alt4				Alt5				Alt6				Alt7a			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/5	10/12	10/28	12/3	12/30	12/22	12/18	12/30	12/24	12/11	12/11	12/23	12/29	12/21	12/18	12/29	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	14	10	10	14	2	2	2	2	2	2	2	2	2	2	2	2	74	74	74	74
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	52	51	51	52	0	0	0	0	52	52	52	52	0	0	0	0	95	95	95	95
Scenario B	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/3	10/17	11/4	12/2	12/28	12/19	12/18	12/29	12/18	12/2	12/8	12/17	n/a	12/25	12/20	n/a	10/12	8/20	10/9	10/9
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	26	21	21	26	8	8	8	8	2	1	1	2	8	8	8	8	69	69	69	69
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	37	36	36	37	3	3	3	3	58	57	58	58	0	0	0	0	82	82	82	82
Scenario C	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	11/26	10/4	10/26	11/19	12/20	12/7	12/11	12/19	12/16	12/1	12/6	12/15	12/20	12/7	12/10	12/19	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	17	13	13	16	4	3	3	3	2	2	2	2	4	3	3	3	71	71	71	71
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	51	51	51	51	1	1	1	1	48	48	48	48	0	0	0	0	87	87	87	87

COLD CONDITION		Alt1	Alt7b				Alt7c				Alt8a				Alt8b				Alt9a				Alt9b				Alt10			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	n/a	12/30	12/21	n/a	12/28	12/17	12/14	12/29	12/11	10/24	10/31	12/9	n/a	12/30	12/21	n/a	10/31	9/20	10/15	10/27	n/a	12/28	12/20	n/a	n/a	12/29	12/20	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	98%	100%	100%	100%	100%	99%	100%	100%	99%	99%	100%	100%	99%
	RW Risk (NC)	0	81	80	77	81	80	76	75	81	14	13	13	14	55	54	51	55	26	26	26	26	65	64	61	65	59	58	55	59
	RW Risk (FL-SC)	0	92	92	89	92	86	83	82	86	54	53	53	54	82	82	79	82	72	72	72	72	89	88	85	89	83	82	79	83
Scenario B	Closure Date	n/a	12/28	12/18	12/17	12/28	12/22	12/9	12/11	12/23	12/7	10/25	11/5	12/6	12/29	12/20	12/18	12/29	11/9	9/27	10/19	11/3	12/26	12/15	12/14	12/26	12/27	12/17	12/16	12/28
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	86	78	77	86	92	82	83	93	36	30	31	36	68	61	59	68	51	48	48	49	87	78	78	87	74	66	65	75
	RW Risk (FL-SC)	0	74	72	72	74	71	70	70	72	64	63	63	64	72	70	70	72	69	68	68	69	76	75	75	76	72	70	70	72
Scenario C	Closure Date	n/a	n/a	12/27	12/19	n/a	12/27	12/16	12/13	12/28	12/6	10/17	10/29	12/5	n/a	12/28	12/20	n/a	10/28	9/15	10/13	10/24	12/31	12/24	12/17	n/a	n/a	12/25	12/18	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
	RW Risk (NC)	0	89	84	77	89	96	86	83	97	19	17	17	19	65	60	53	65	35	35	35	35	82	77	70	82	71	71	71	71
	RW Risk (FL-SC)	0	88	87	84	88	82	78	77	82	52	51	51	52	78	76	73	78	67	67	67	67	83	81	78	83	78	75	73	78

Sensitivity Runs: Mean, warm, and cold conditions whale distributions, catch rate projection scenarios 1-4 (i.e., observed 2008/09 winter catch rates, observed 2013/14 summer catch rates scaled to account for higher winter CPUE, observed 2013/14 summer catch rates, and mean observed 2006/07-2008/09 winter catch rates) and spatial fishing distribution scenarios A-C (i.e., based on Nov-Apr 2008/09 pot distribution with 2013/14 soak times, based on 2013/14 June-October pot distribution and soak times, based on mean Nov-Apr 2006/07-2008/09 pot distribution with 2013/14 soak times).

Table 3. Ranked projected risk of right whale entanglement in pot gear vertical lines (in relative risk units; RRU) under proposed Alternatives in Regulatory Amendment 16.

NARW Protection	Alternative
Most Protective	**Alternative 1:** no relative risk of entanglement (0 RRU)
	Alternative 6: low increase in relative risk off NC (+2-8 RRU); no additional risk off FL-SC (0 RRU).
	Alternative 4: low increase in relative risk off NC (+2-8 RRU); low increase in relative risk off FL-SC (+0-3 RRU).
	Alternative 5: low increase in relative risk off NC (+1-2 RRU); low to high increase in relative risk off FL-SC (+11-58 RRU).
	Alternative 3: low to moderate increase in relative risk off NC (+10-26 RRU); low to high increase in relative risk off FL-SC (+16-52 RRU).
	Alternative 8a: low to moderate increase in relative risk off NC (+13-36 RRU); low to high increase in relative risk off FL-SC (+13-64 RRU).
	Alternative 9a: moderate to high increase in relative risk off NC (+26-51 RRU); moderate to high increase in relative risk off FL-SC (+30-72 RRU).
	Alternative 7a: high increase in relative risk off NC (+69-74 RRU); very high increase in relative risk off FL-SC (+77-96 RRU).
	Alternative 8b: high increase in relative risk off NC (+51-68 RRU); high to very high increase in relative risk off FL-SC (+61-89 RRU).
	Alternative 10: high to very high increase in relative risk off NC (+55-75 RRU); high to very high increase in relative risk off FL-SC (+62-89 RRU).
	Alternative 9b: high to very high increase in relative risk off NC (+61-87 RRU); high to very high increase in relative risk off FL-SC (+67-94 RRU).
	Alternative 7c: high to very high increase in relative risk off NC (+75-97 RRU) and off FL-SC (+67-100 RRU).
	Alternative 7b: very high increase in relative risk off NC (+77-89 RRU); high to very high increase in relative risk off FL-SC (+70-106 RRU).
Least Protective	**Alternative 2:** very high increase in relative risk off NC (+100 RRU over status quo) and off FL-SC (+100 RRU).
Risk Classification	1-25 RRU = low, 26-50 RRU = moderate, 51-75 RRU= high, 76-100+ RRU = very high

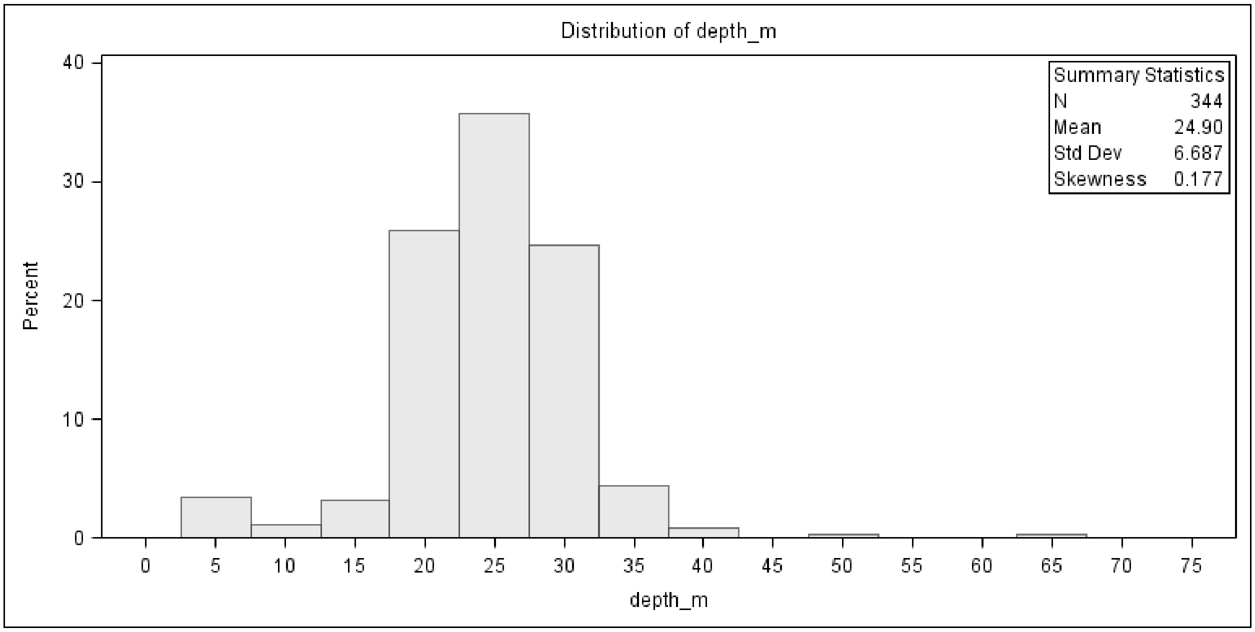


Figure 1. Histogram of reported depth of fishing (m) by commercial black sea bass pot gear endorsement holders for the 2012/13 and 2013/14 fishing seasons.

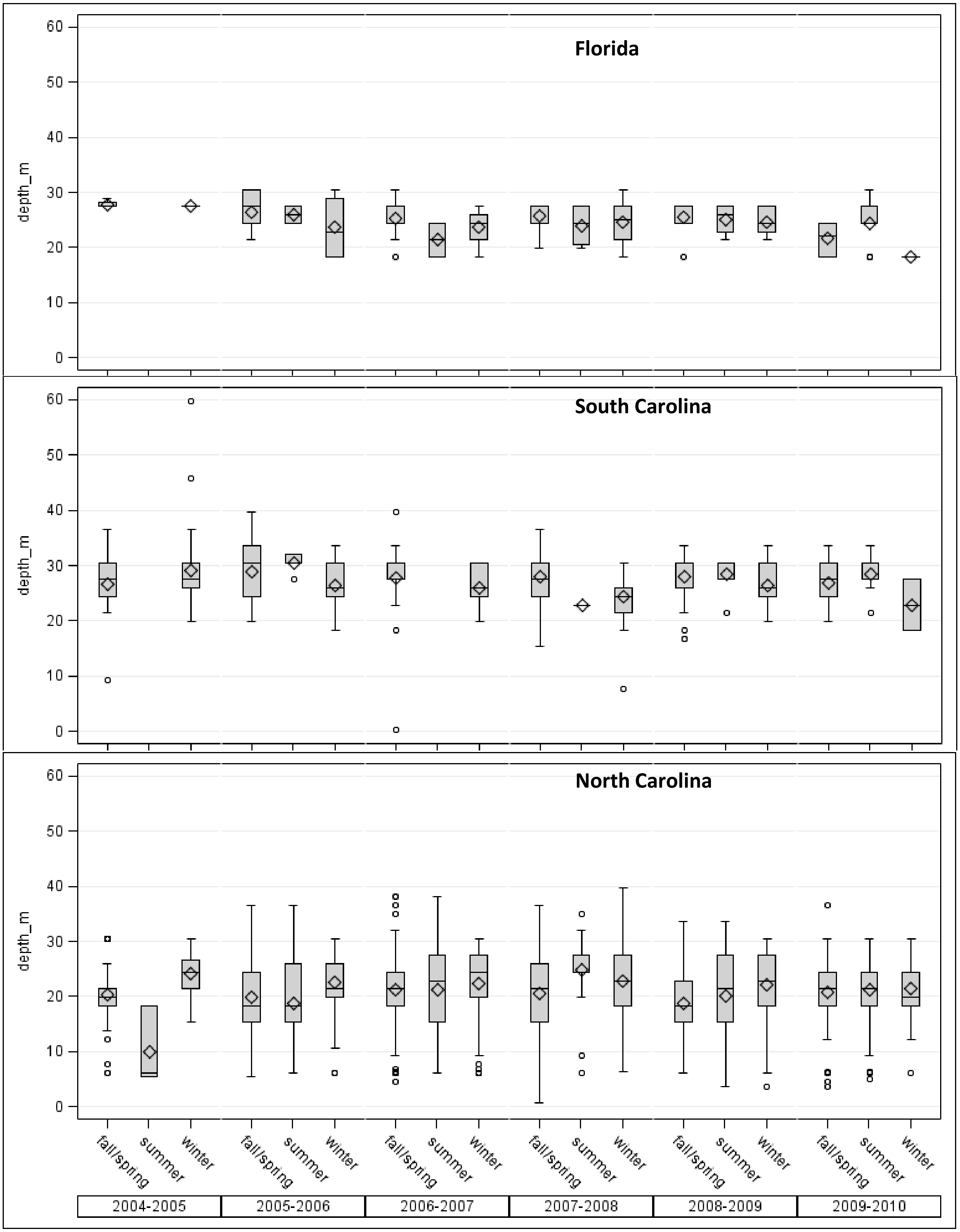


Figure 2. Boxplots of captain-reported depth of fishing (ft) for black sea bass pot gear endorsement holders, by state, fishing year, and season (summer: Jul-Aug, winter: Dec-Feb, fall/spring: Mar-Jun, Sept-Nov).

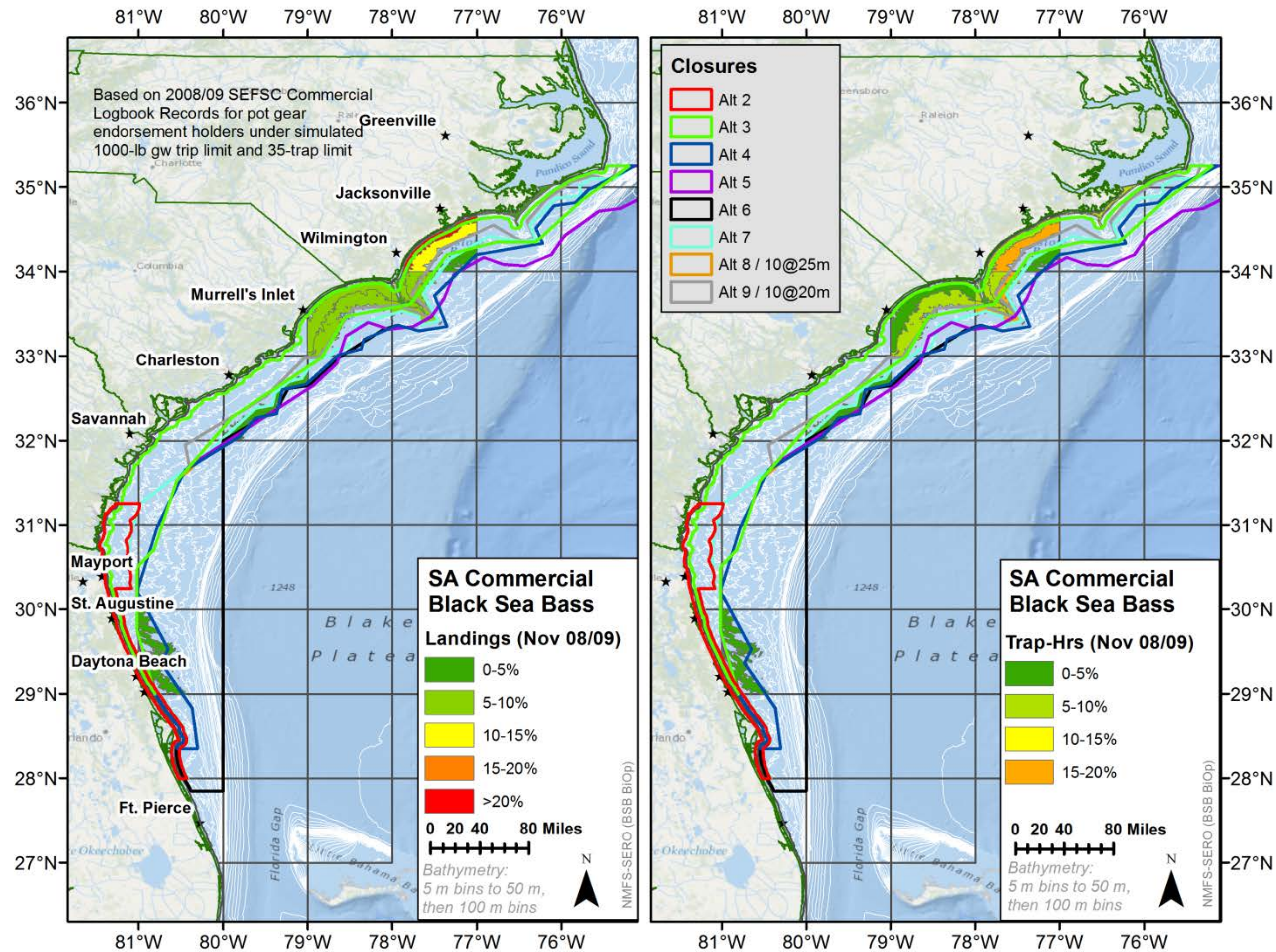


Figure 3: Scenario A (November). Spatial distribution of reported South Atlantic commercial black sea bass pot gear endorsement holder landings and effort under Amendment 18A regulations, by area and depth, for (A)-(F) most recent winter season (2008/09; by month) ['Scenario A'], (G) most recent season (2013/14) ['Scenario B'], and (H)-(M) mean of last three (2006/07-2008/09) winter seasons ['Scenario C']. Landings and effort are aggregated into 5-m wide by 1° tall bins and expressed as percentages of the total to maintain confidentiality. Bathymetry and shoreline courtesy ESRI Ocean Basemap.

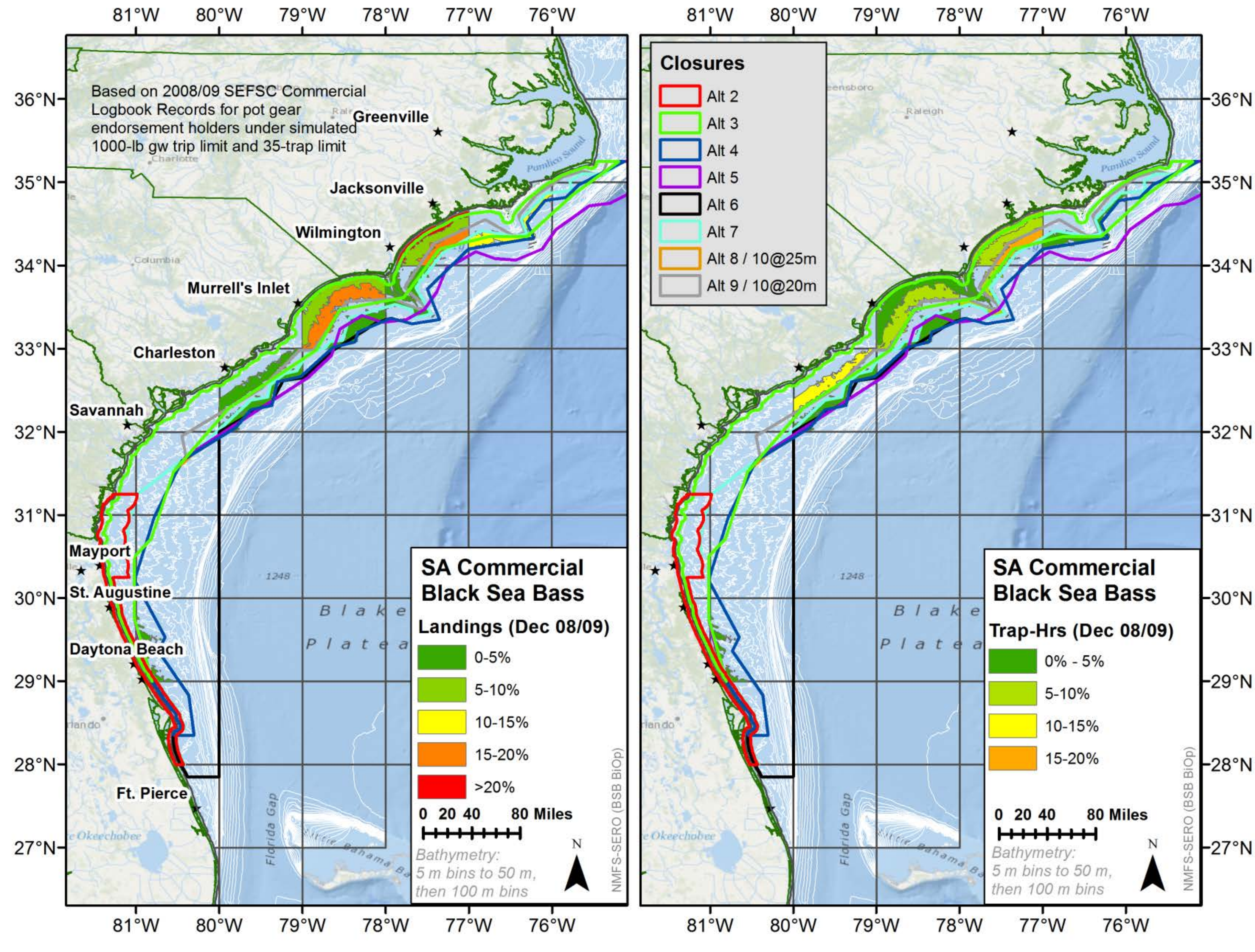


Figure 3B: Scenario A (December)

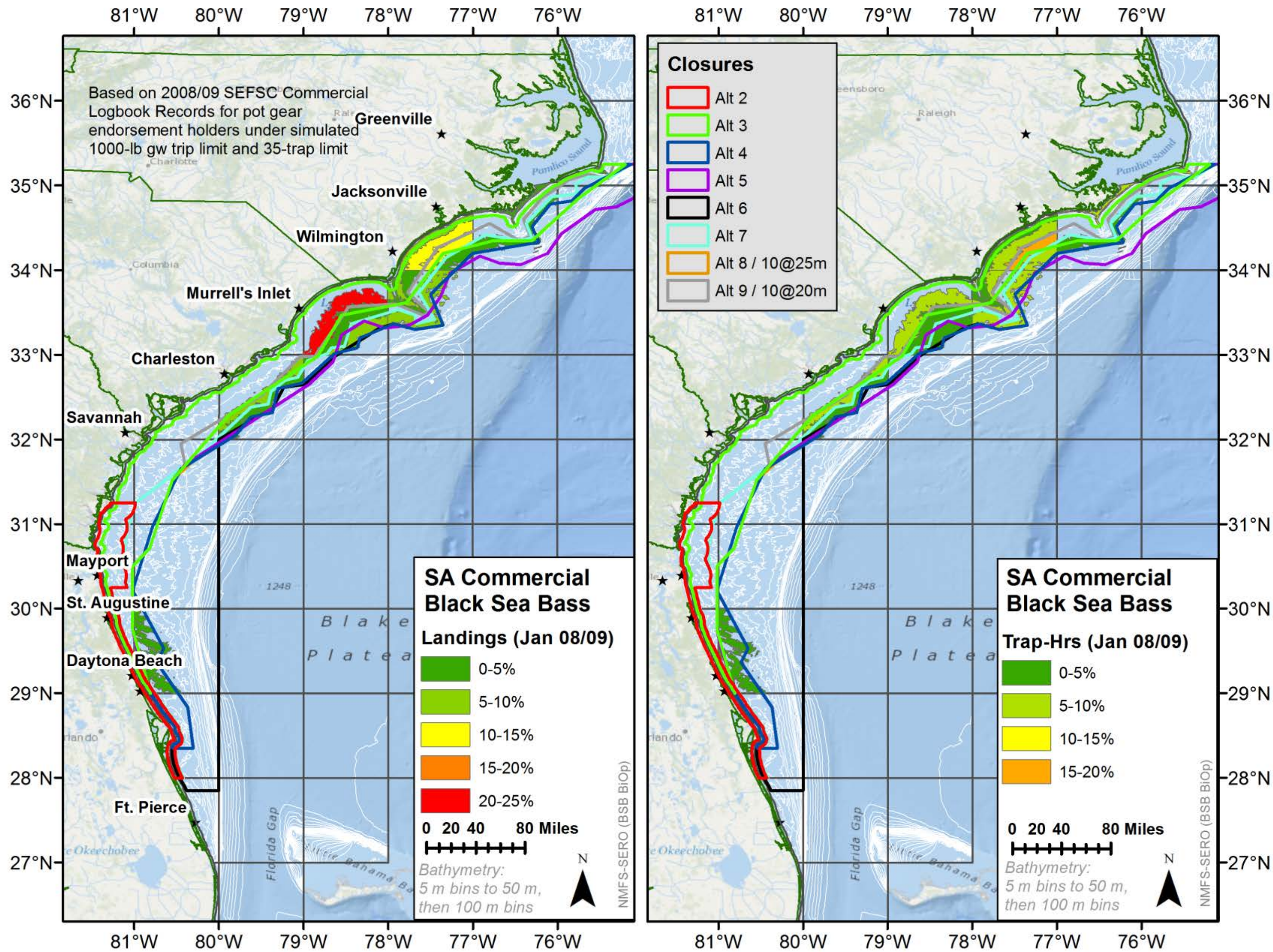


Figure 3C: Scenario A (January)

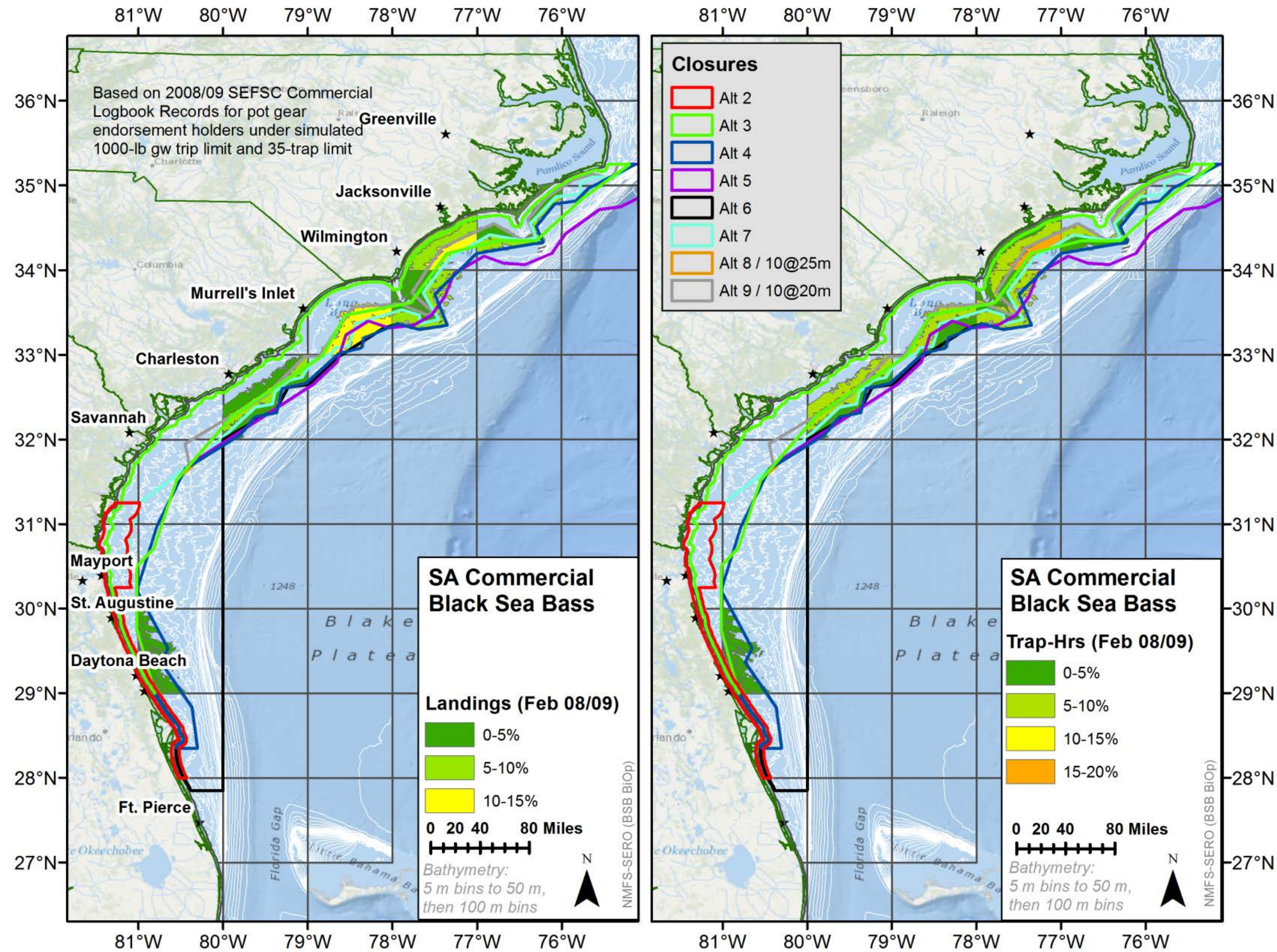


Figure 3D: Scenario A (February)

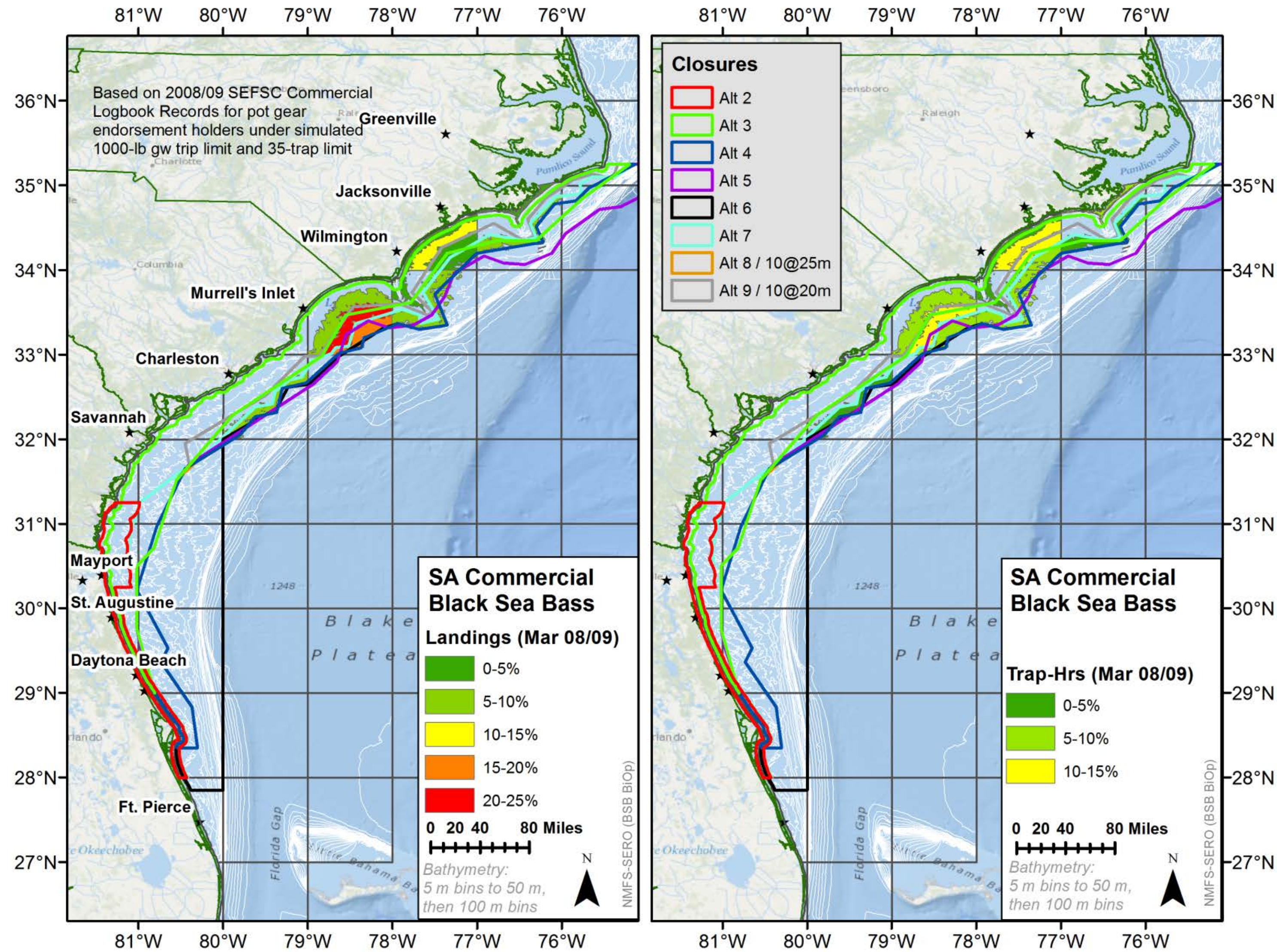


Figure 3E: Scenario A (March)

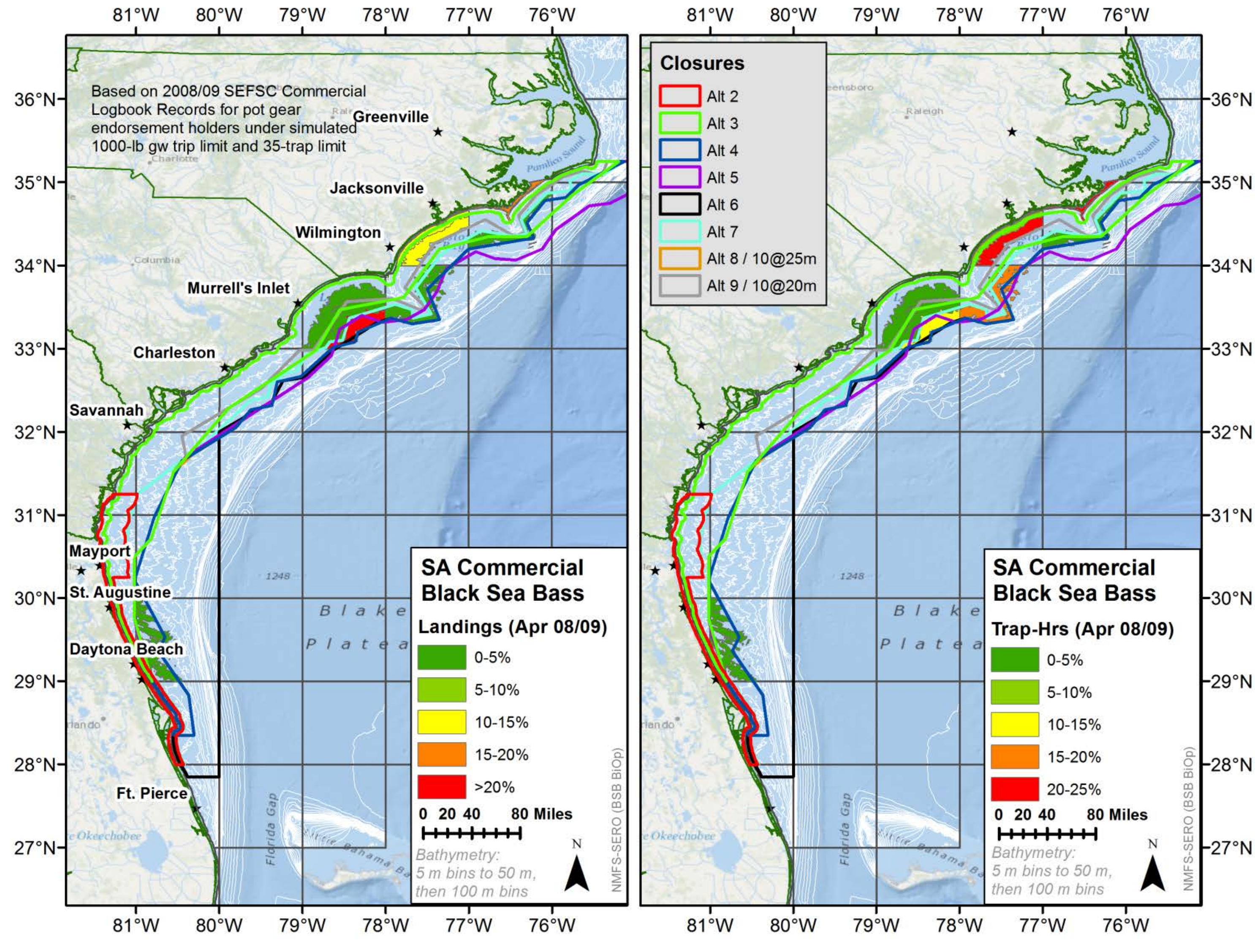


Figure 3F: Scenario A (April)

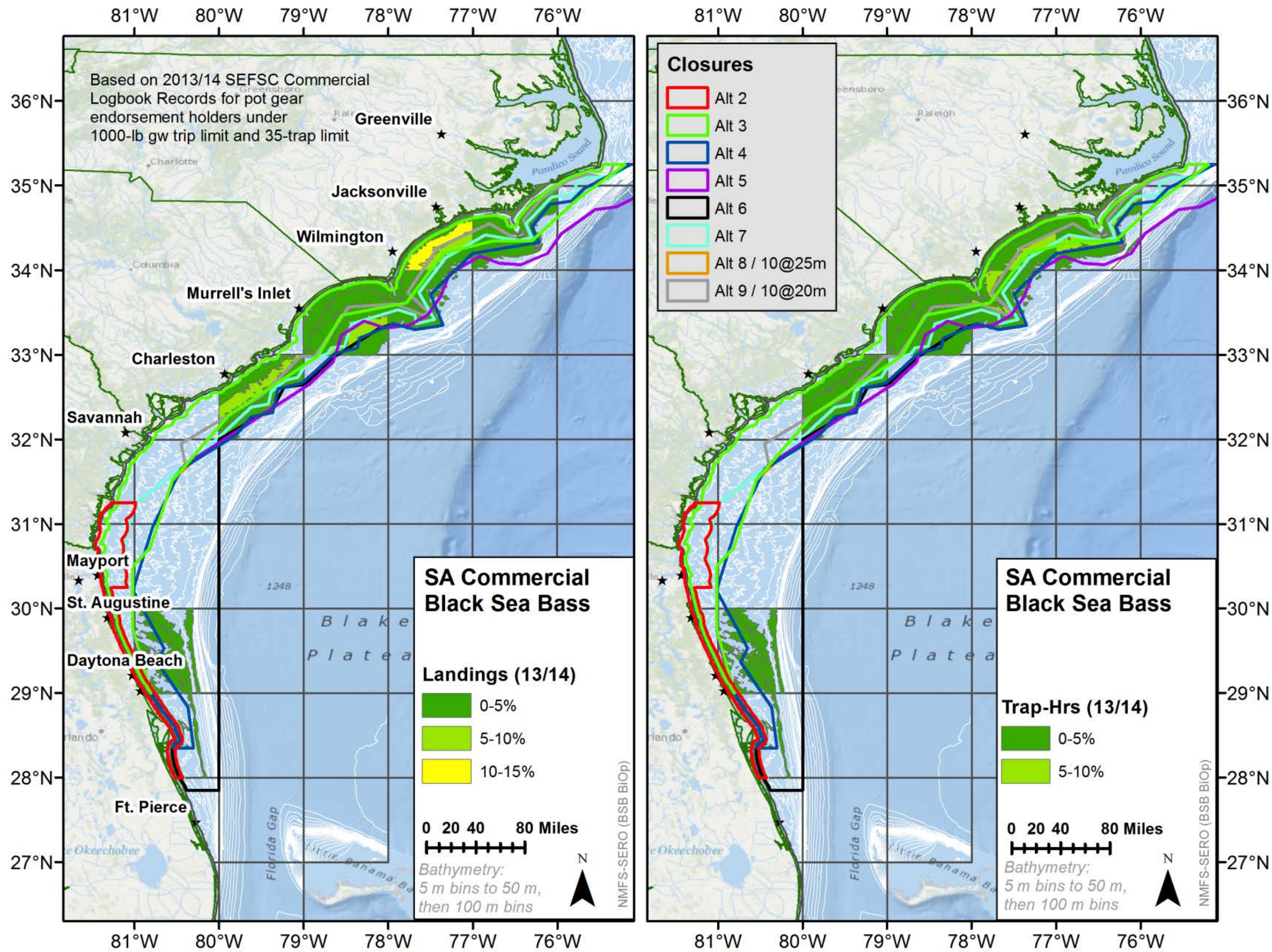


Figure 3G: Scenario B (Nov-Apr)

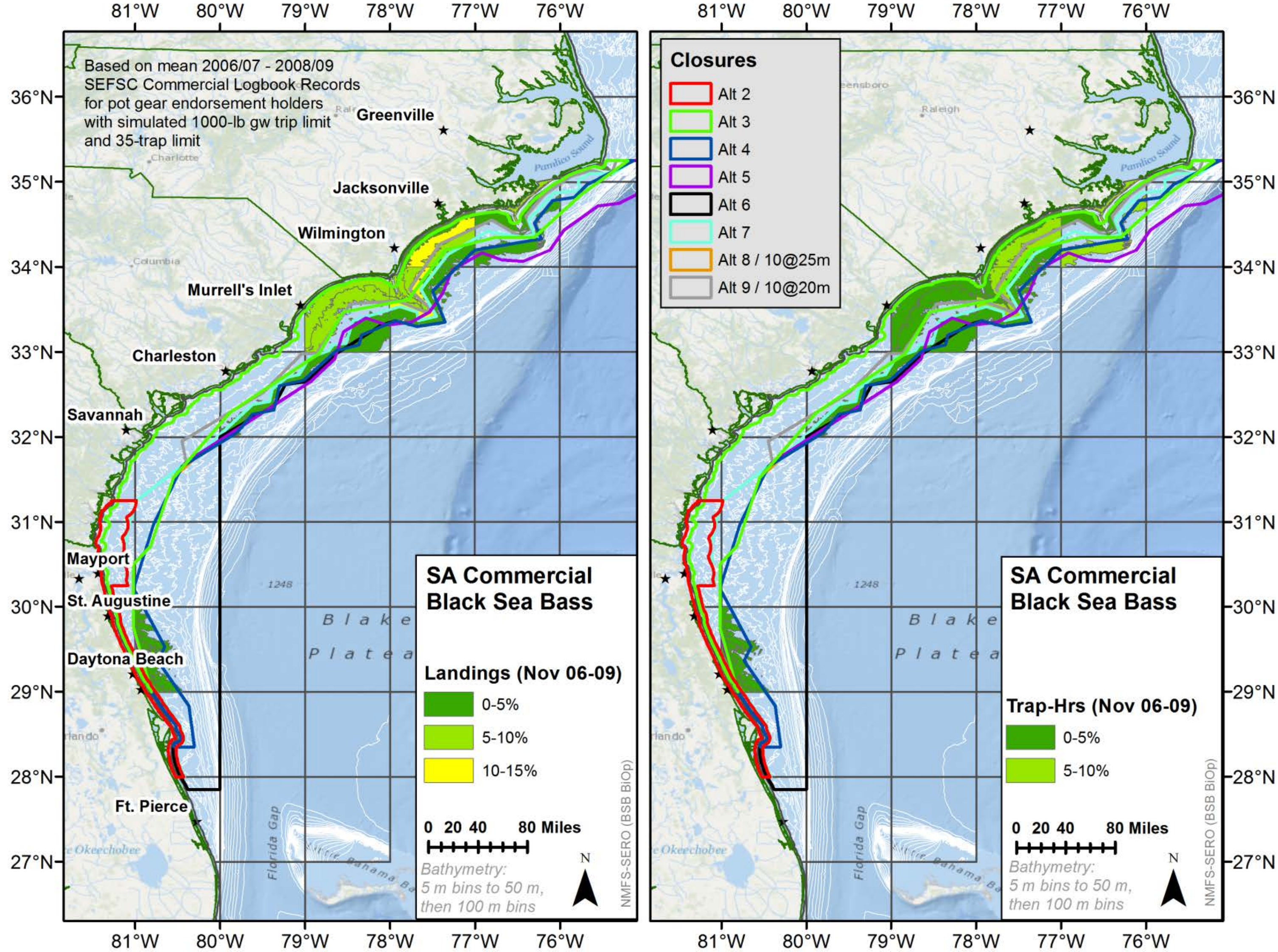


Figure 3H: Scenario C (November)

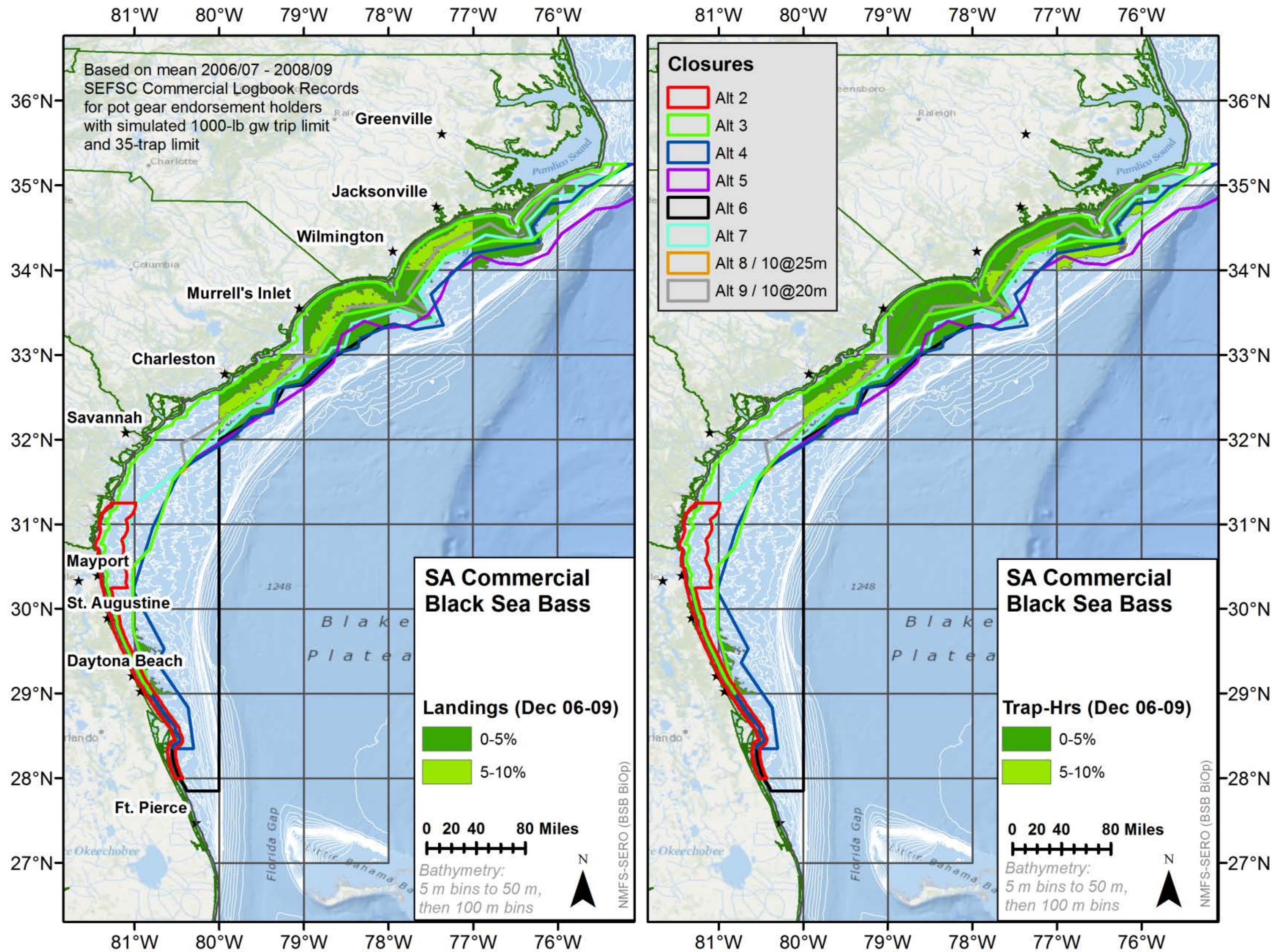


Figure 3I: Scenario C (December)

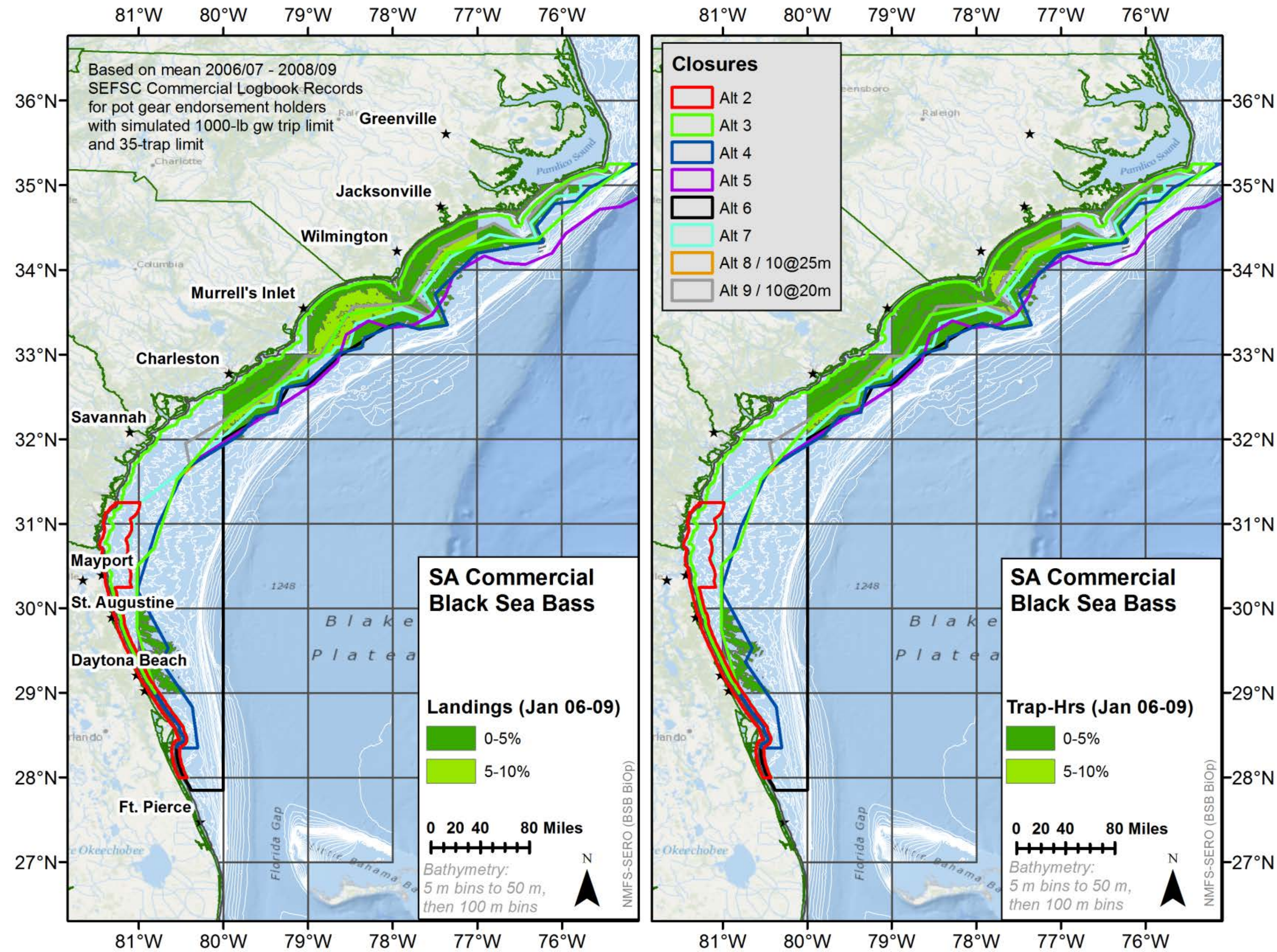


Figure 3J: Scenario C (January)

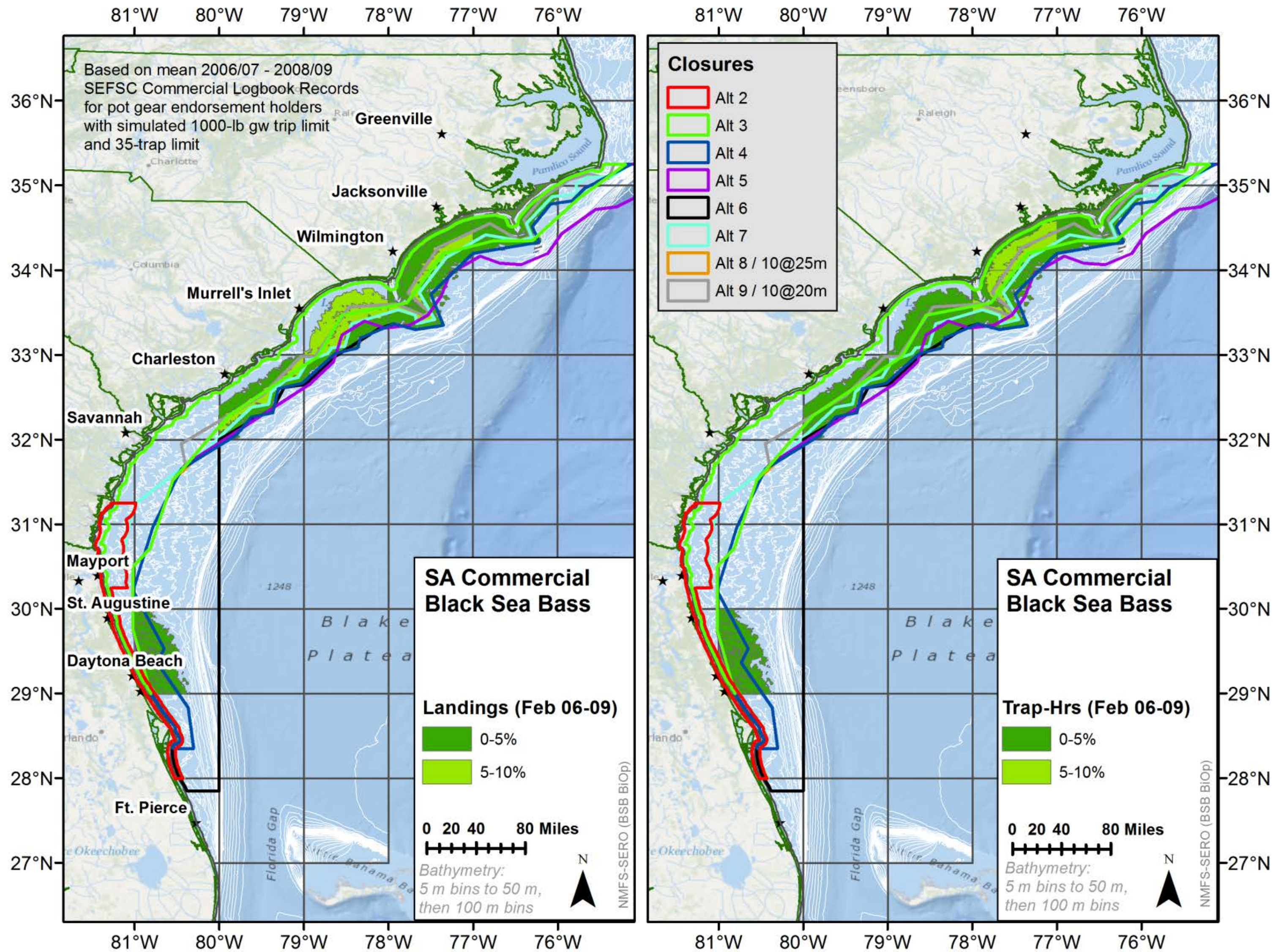


Figure 3K: Scenario C (February)

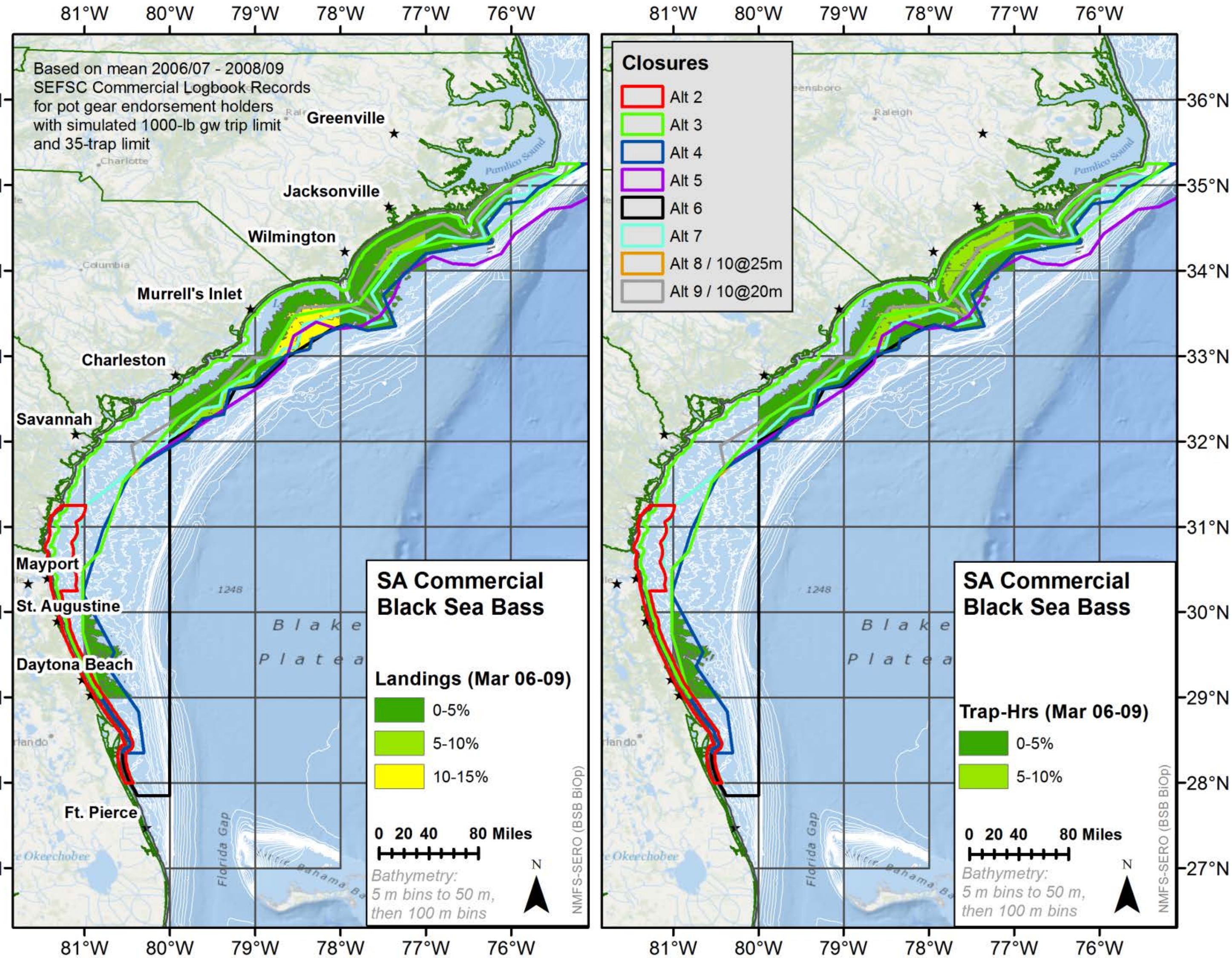


Figure 3L: Scenario C (March)

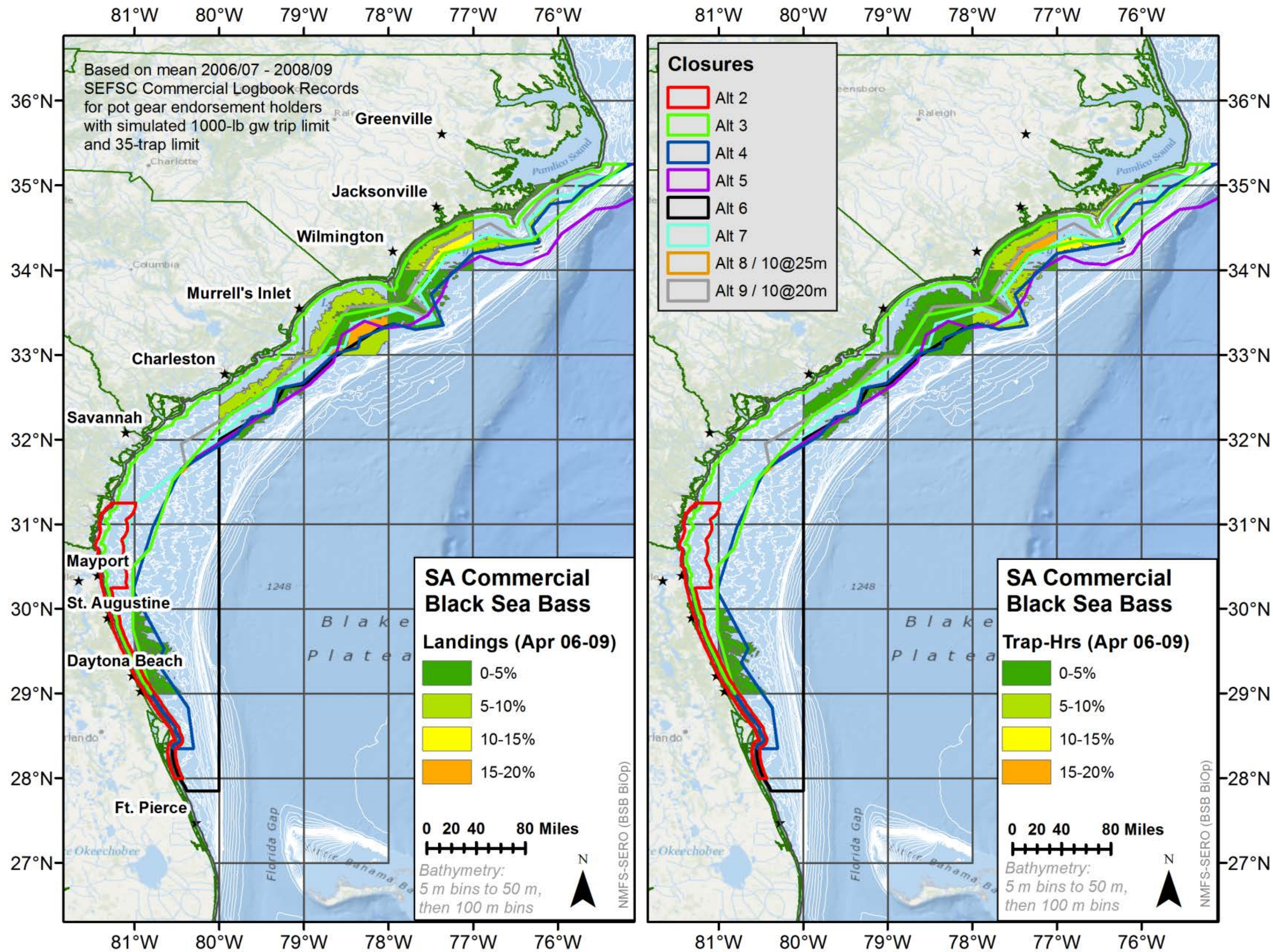


Figure 3M: Scenario C (Apr)

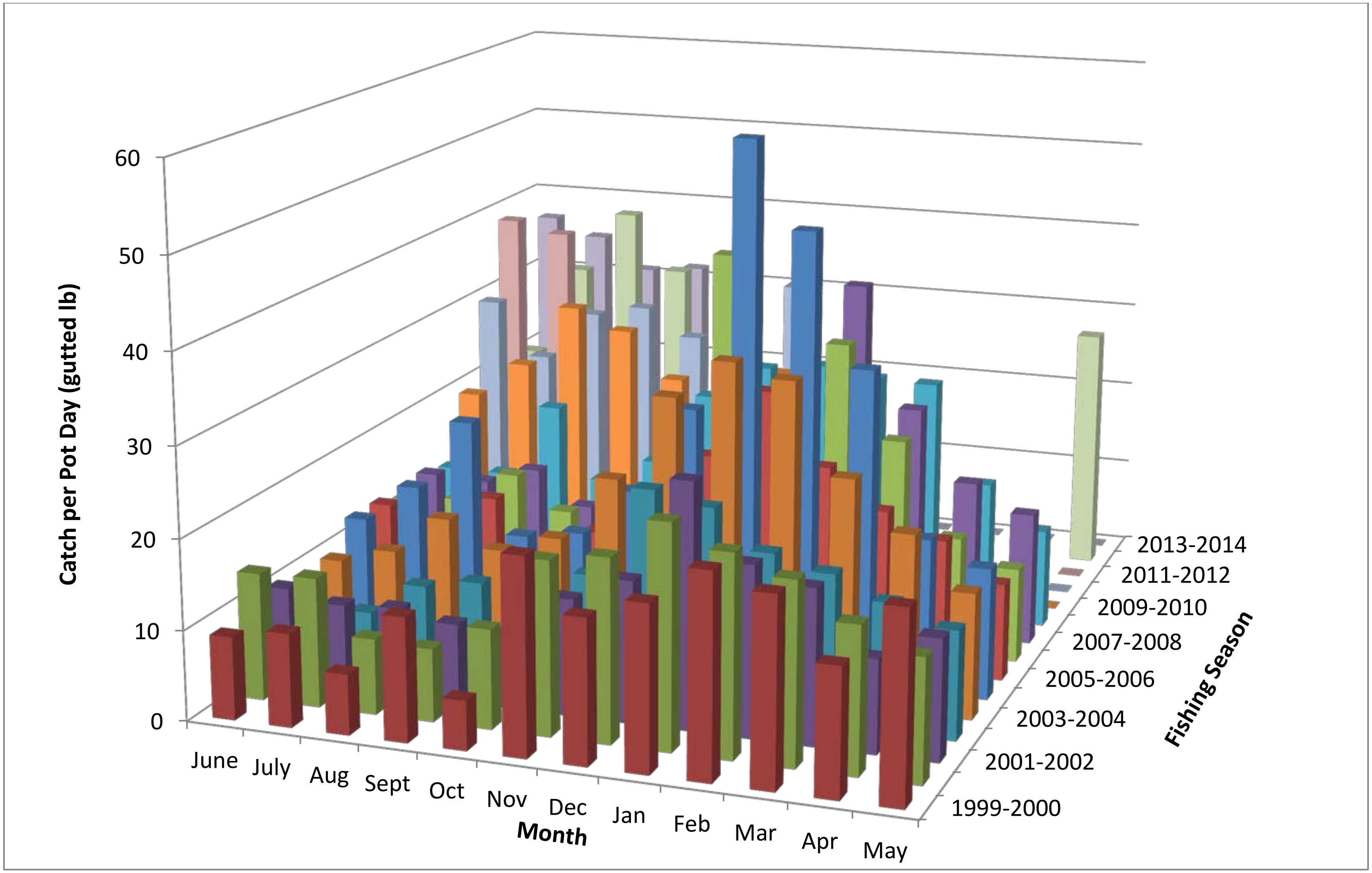


Figure 4. Catch-per-pot day by commercial black sea bass pot gear endorsement holders by fishing month and season, as reported to SEFSC Commercial Logbooks (accessed 20 Feb 2014). Note the shift from high winter catch rates to high summer catch rates as derby conditions emerged in the later years.

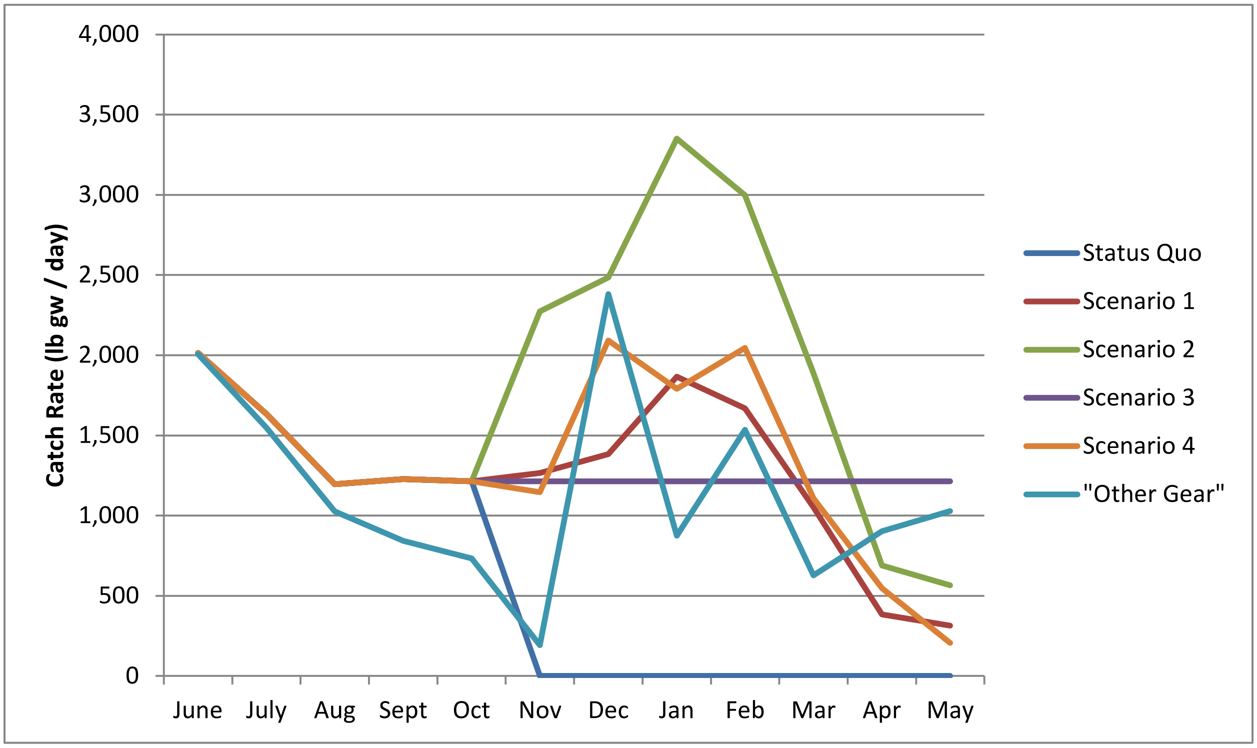


Figure 5. Black sea bass commercial pot endorsement holder projected catch rate, expressed as landings in gutted pounds per day of fishing, for three scenarios as well as status quo and other gear catch rate.

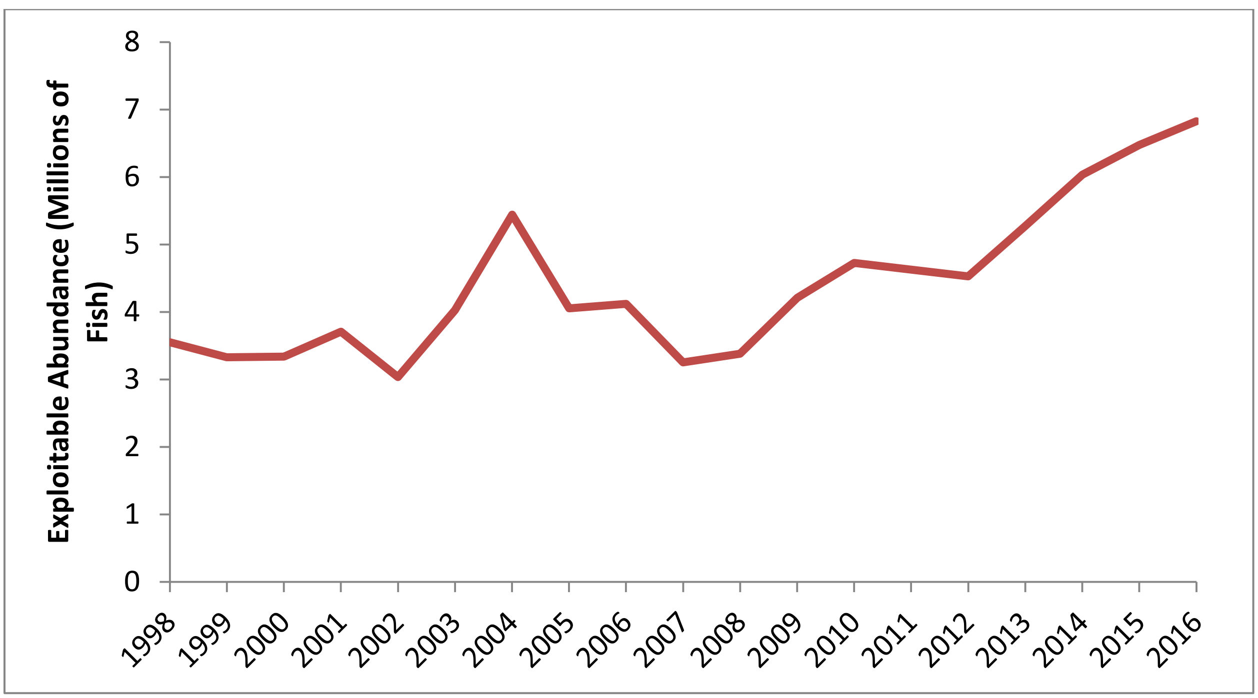


Figure 6. Abundance (in millions of fish) available to black sea bass commercial pot gear, from SEDAR-25 (2012) assessment.

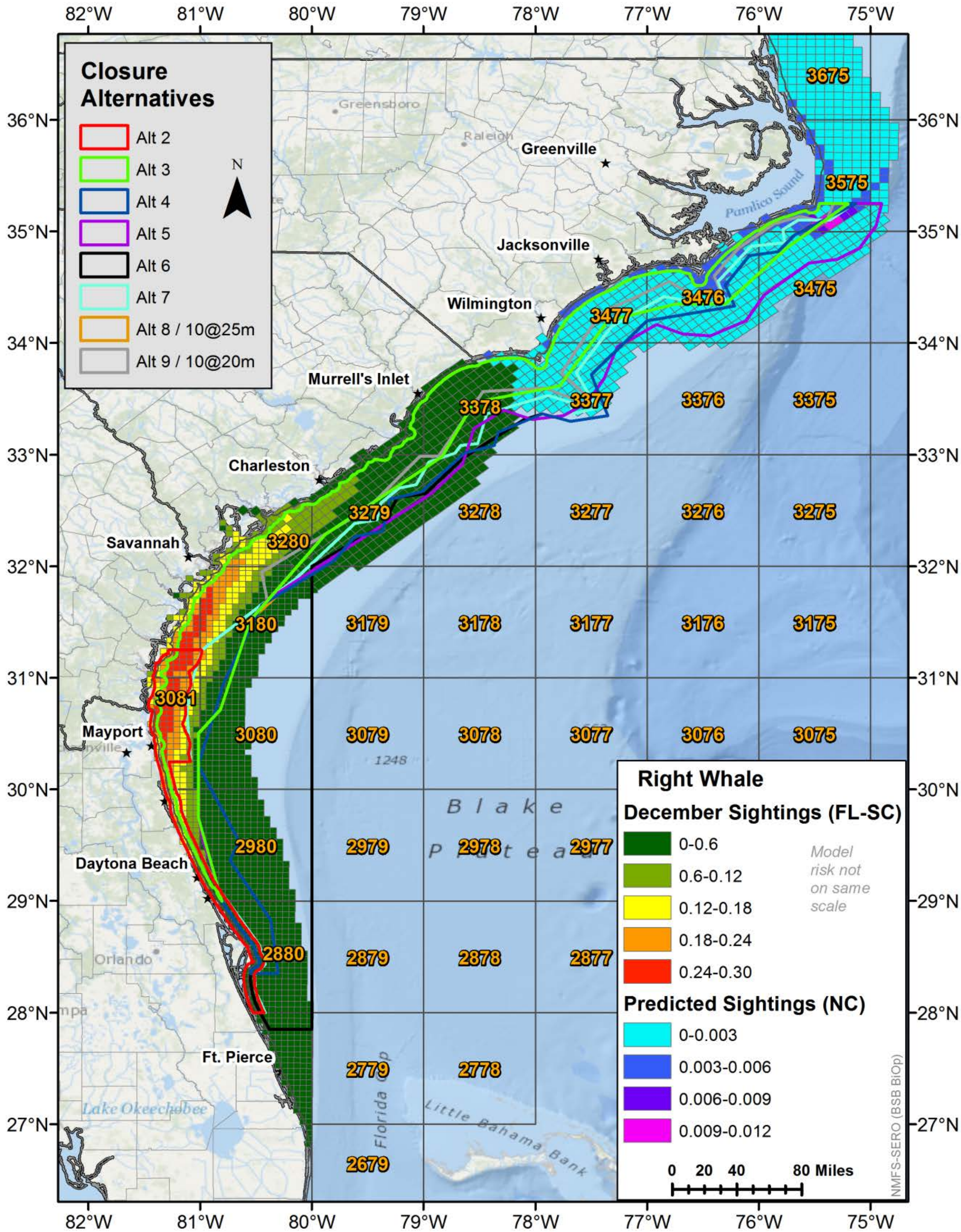


Figure 7A. December right whale predicted distribution based on modeled right whale habitat from right whale sightings from 2003/2004 through 2012/2013 (Gowan and Ortega-Ortiz 2014, Gowan pers. comm.). Note NC model is not time-dynamic due to limited sampling. Note December abundance was used as a proxy for November, which was not modeled due to limited sampling. National Marine Fisheries Service commercial logbook reporting grids are labeled in orange. Bathymetry and shoreline courtesy ESRI Ocean Basemap. NC and FL-SC predictions are not directly comparable in scale.

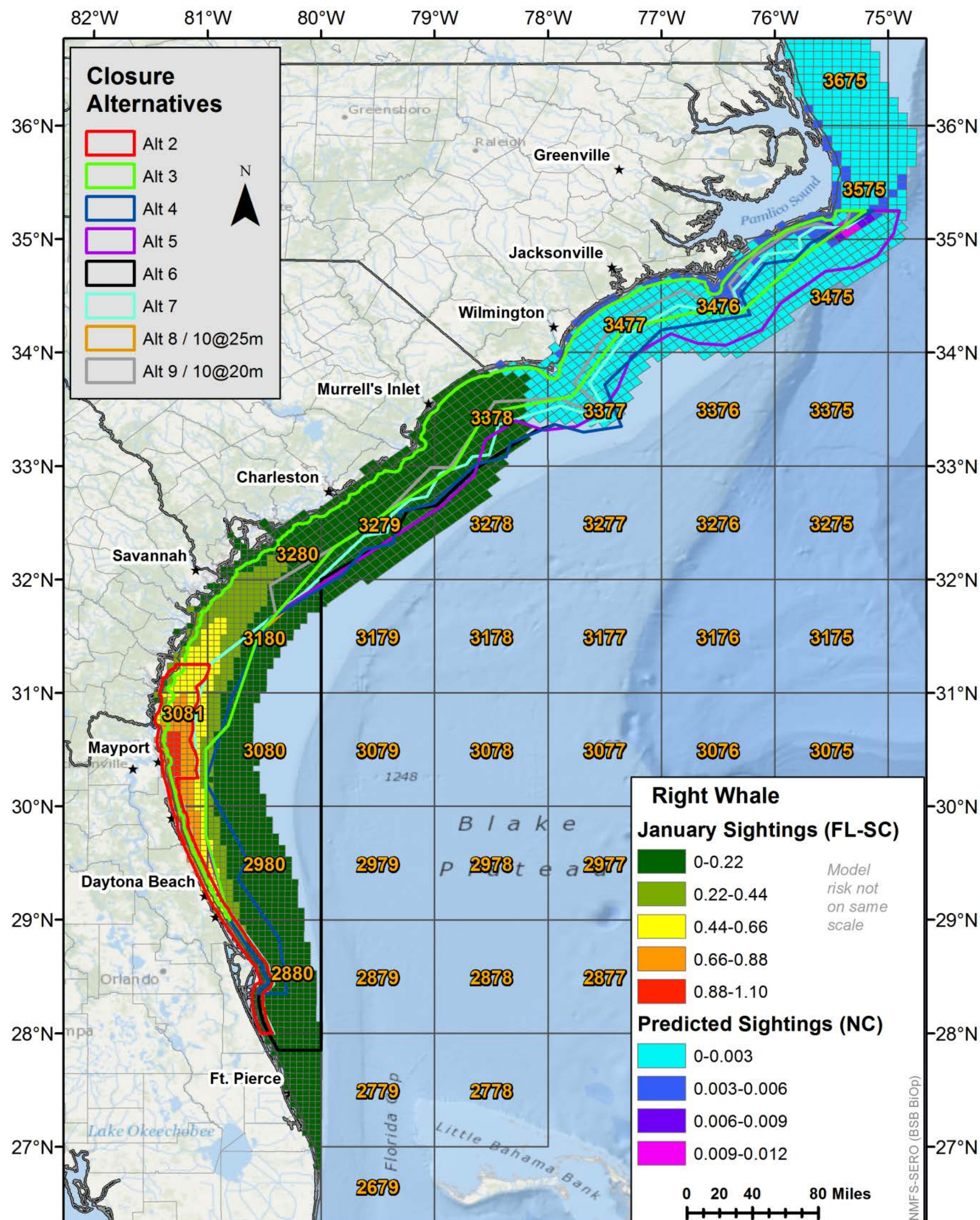


Figure 7B. January right whale predicted distribution based on modeled habitat from right whale sightings from 2003/2004 through 2012/2013. Note NC model is not time-dynamic due to limited sampling. National Marine Fisheries Service commercial logbook reporting grids are labeled in orange. Bathymetry and shoreline courtesy ESRI Ocean Basemap. NC and FL-SC predictions are not directly comparable in scale.

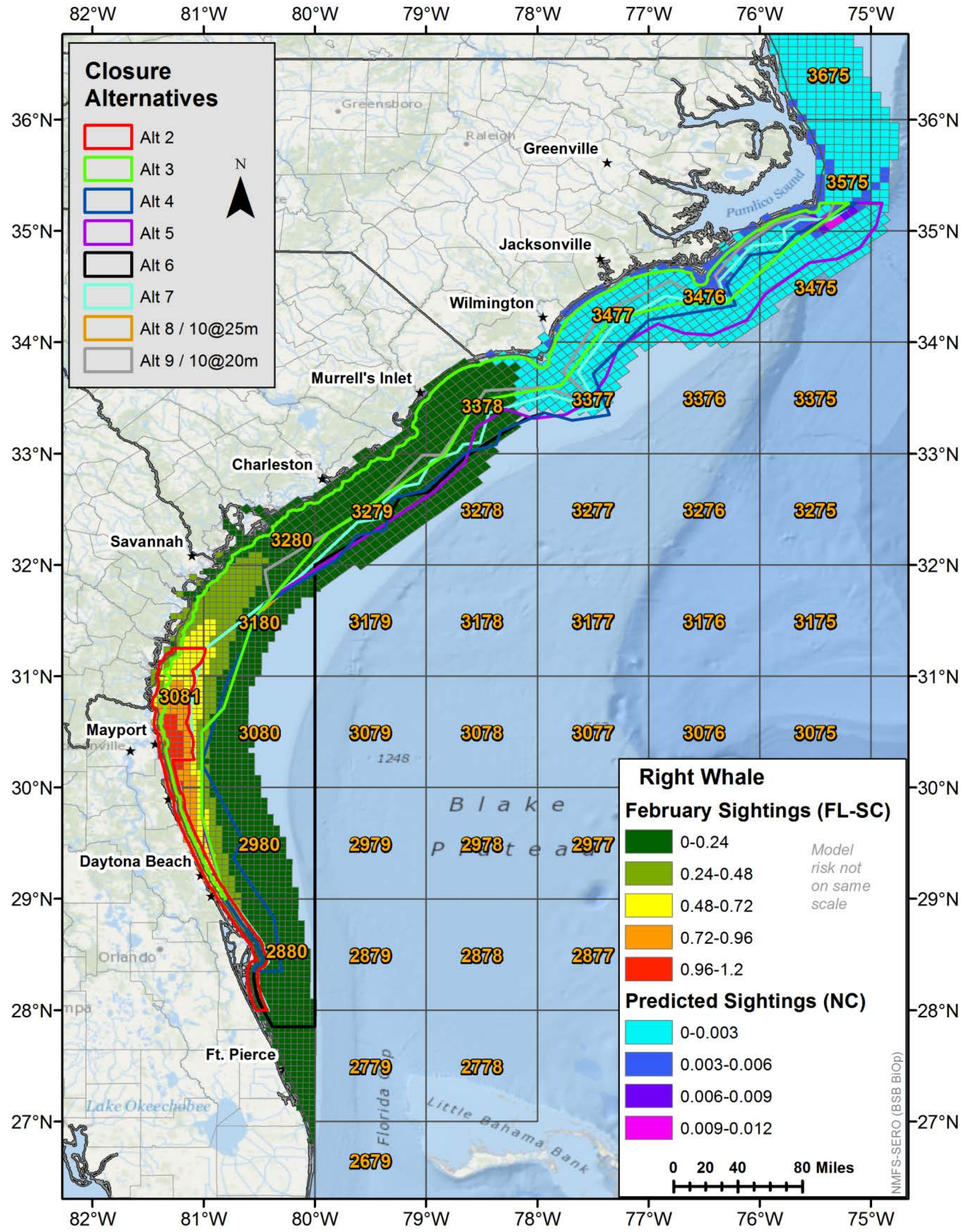


Figure 7C. February right whale predicted distribution based on modeled habitat from right whale sightings from 2003/2004 through 2012/2013. Note NC model is not time-dynamic due to limited sampling. National Marine Fisheries Service commercial logbook reporting grids are labeled in orange. Bathymetry and shoreline courtesy ESRI Ocean Basemap. NC and FL-SC predictions are not directly comparable in scale.

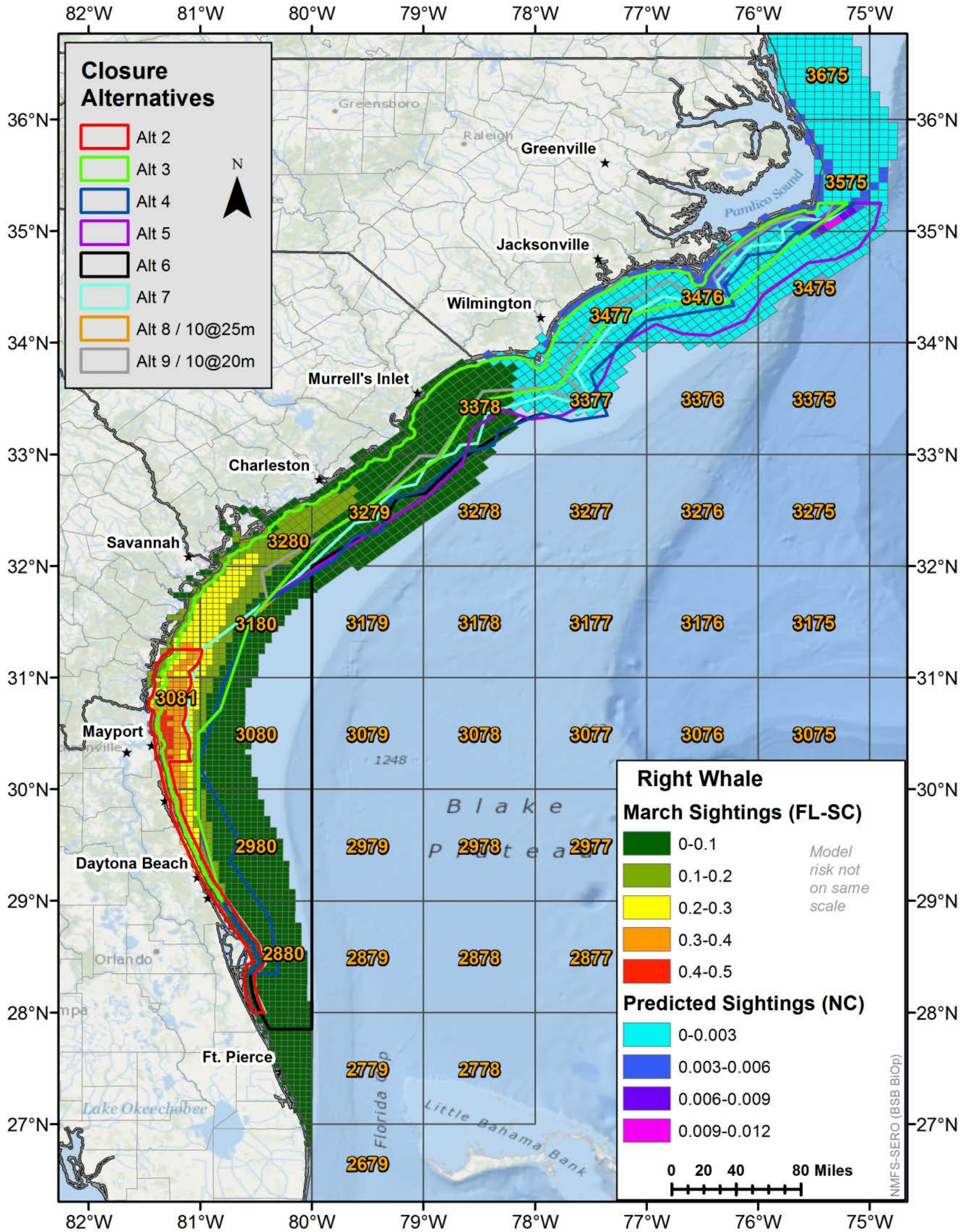


Figure 7D. March right whale predicted distribution based on modeled habitat from right whale sightings from 2003/2004 through 2012/2013. Note NC model is not time-dynamic due to limited sampling. Note March abundance was used as a proxy for April, which was not modeled due to limited sampling. National Marine Fisheries Service commercial logbook reporting grids are labeled in orange. Bathymetry and shoreline courtesy ESRI Ocean Basemap. NC and FL-SC predictions are not directly comparable in scale.

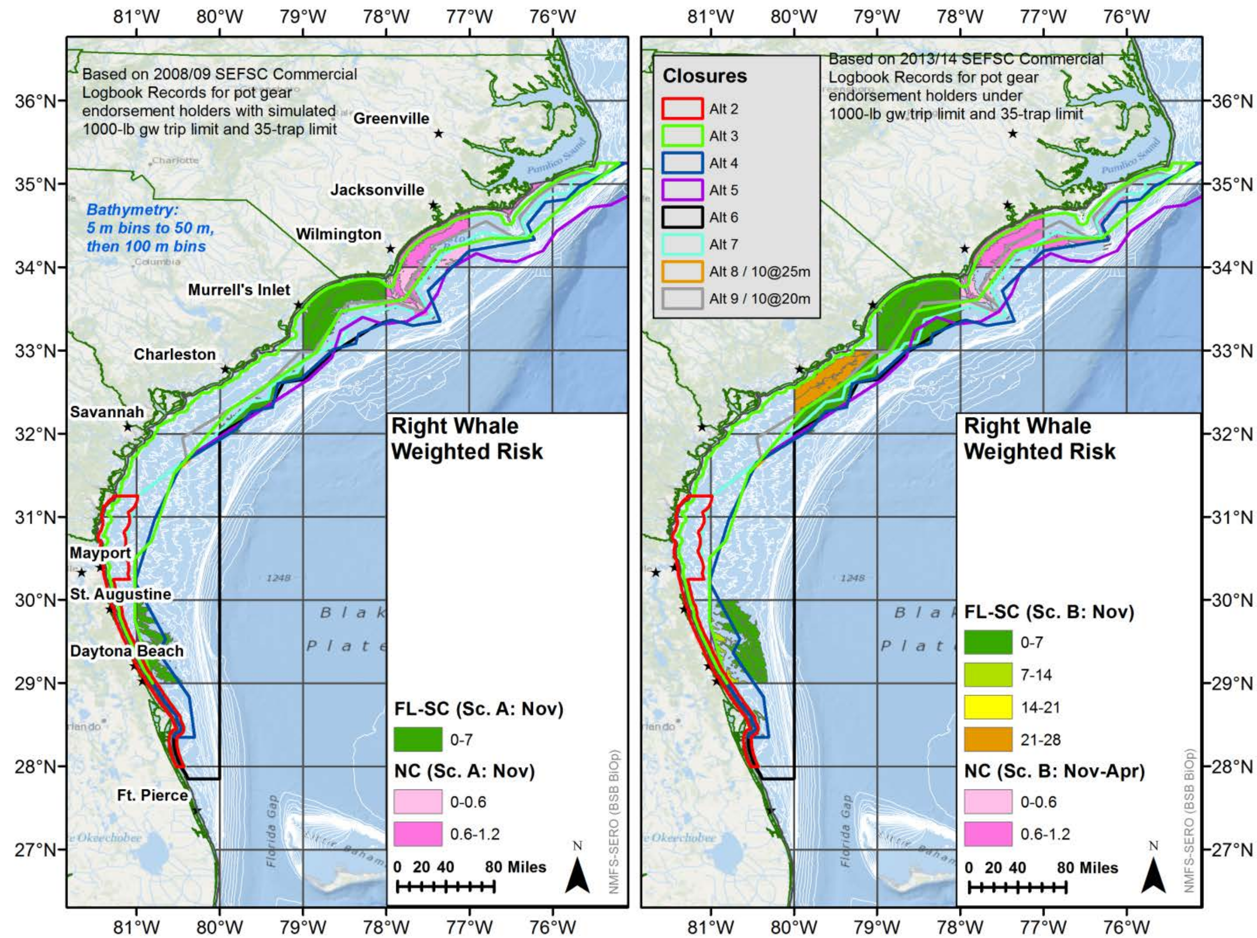


Figure 8A: November. Right whale predicted monthly relative risk based on right whale habitat models and estimated commercial pot gear effort by area-depth grid. Under Scenario A (left), spatial distribution of effort is based on observations from the 2008/09 winter fishing season. Under Scenario B (right), spatial distribution of pot effort is based on observations from the summer 2013/14 season. Note underlying NC right whale 'relative abundance' model is not time-dynamic due to limited sampling. Bathymetry and shoreline courtesy NOAA NGDC Coastal Relief Model and ESRI Ocean Basemap. Note weighted risk is a unitless, relative scalar. NC and FL-SC modeled risk are not directly comparable. Note Scenario C relative risk was similar to Scenario A and is not depicted.

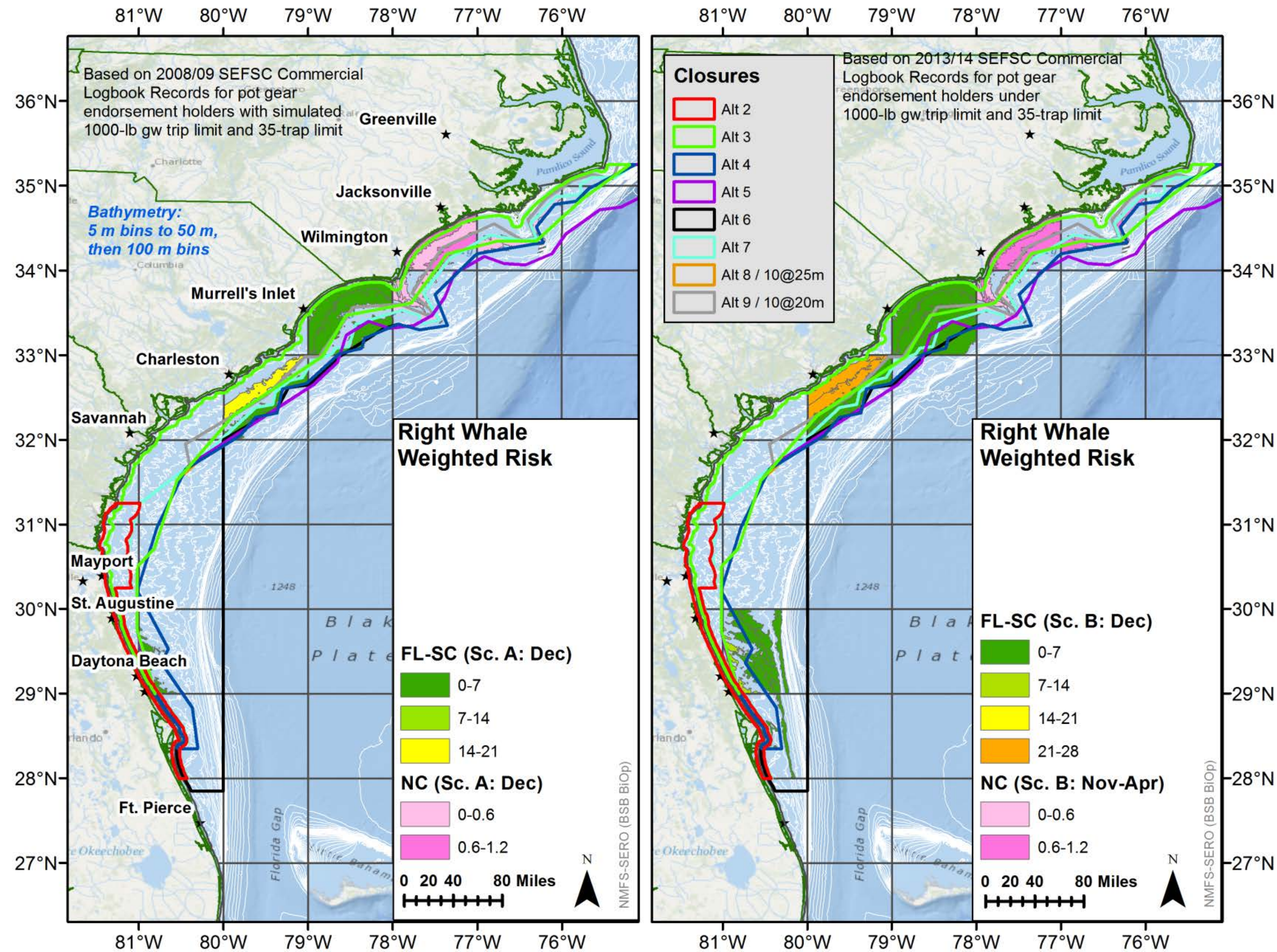


Figure 8B: December

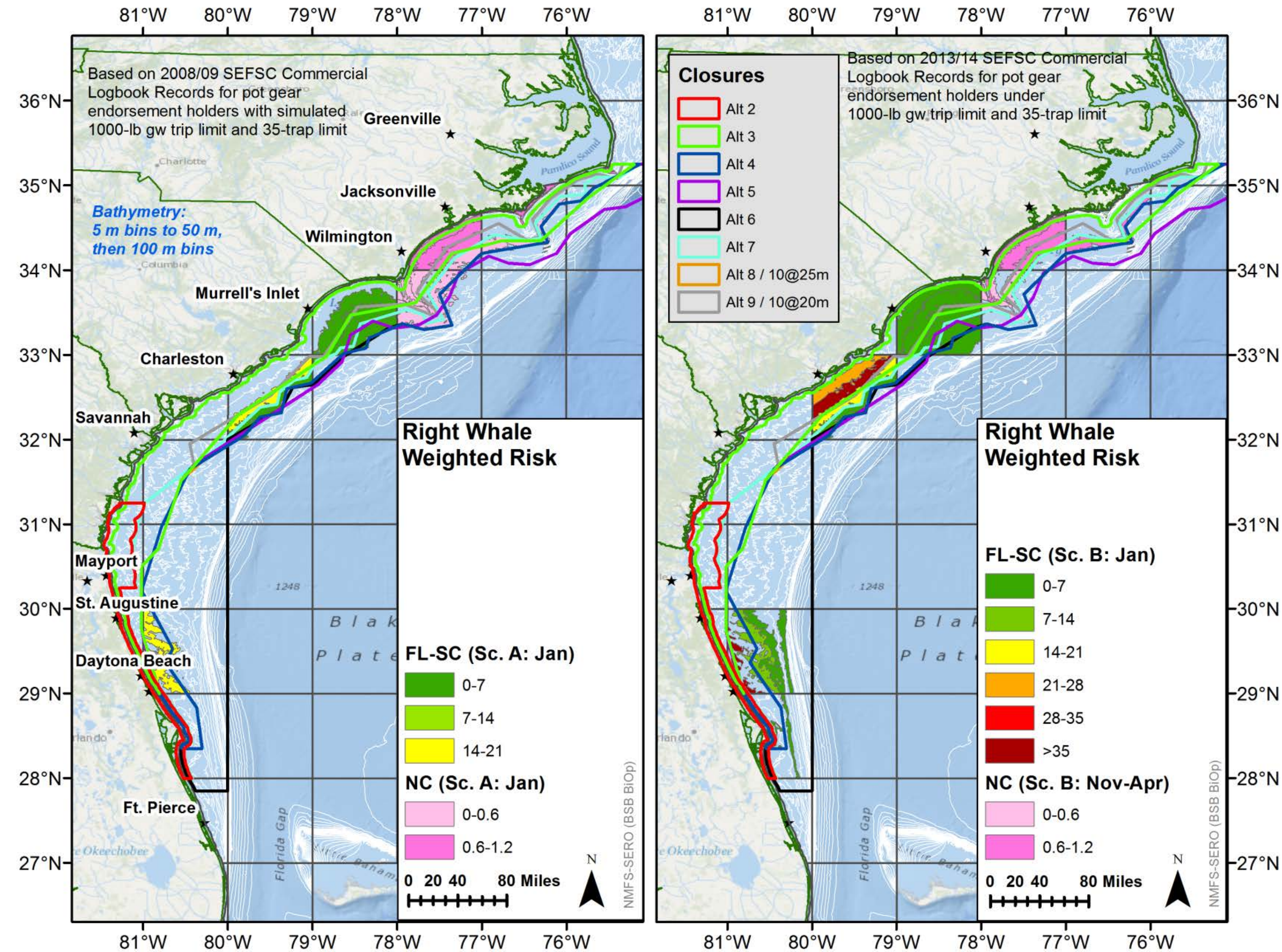


Figure 8C: January

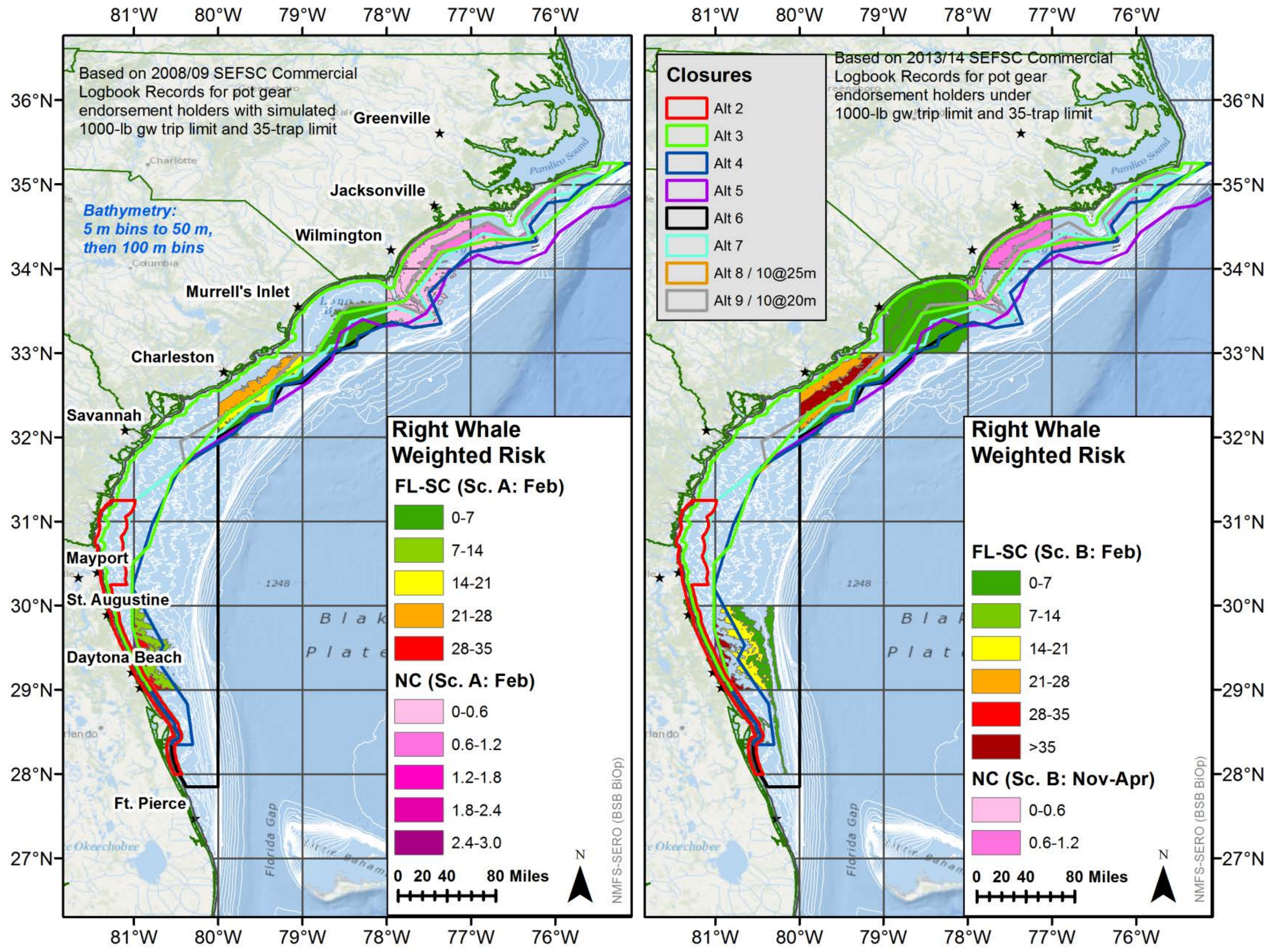


Figure 8D: February

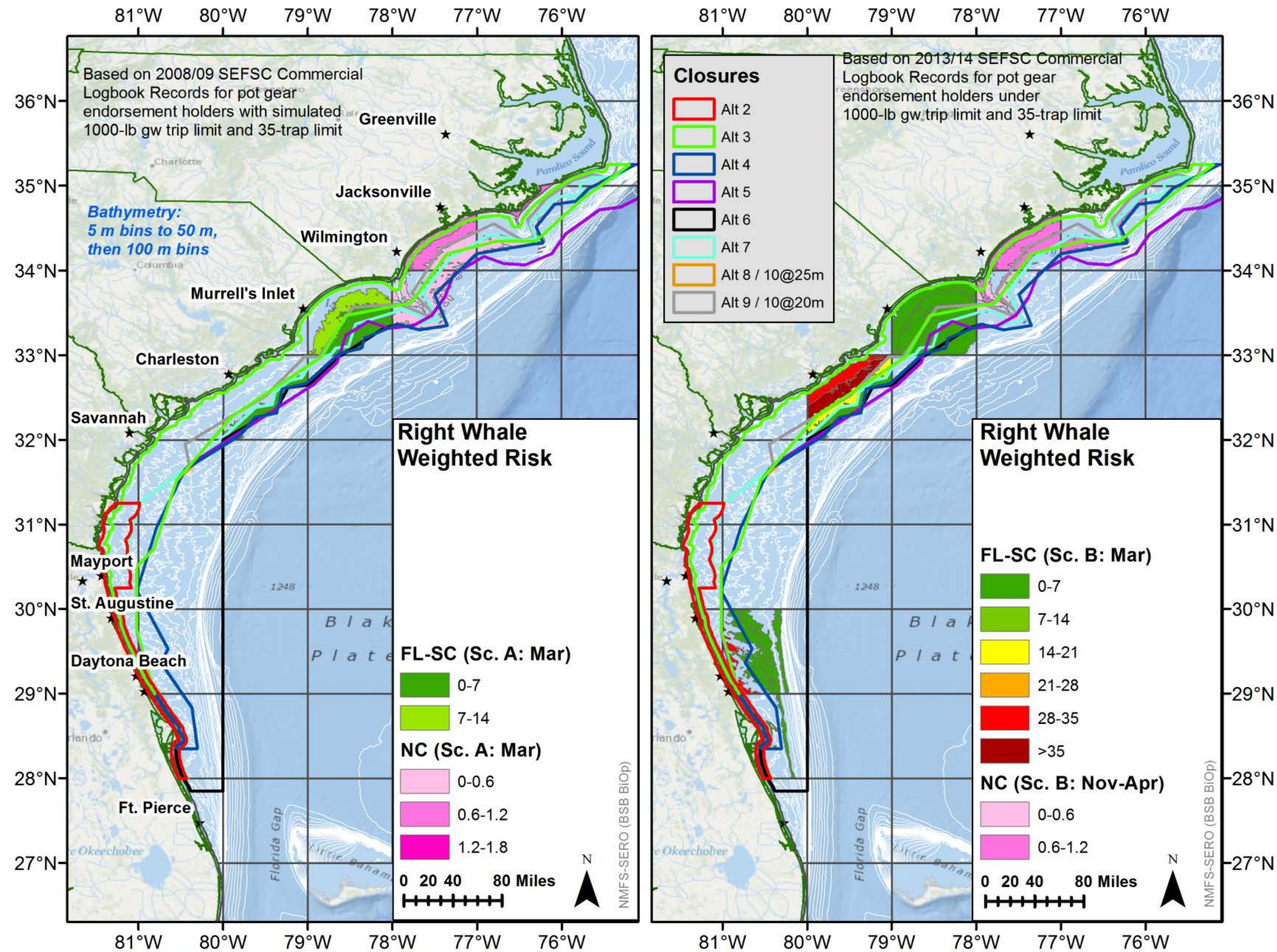


Figure 8E: March

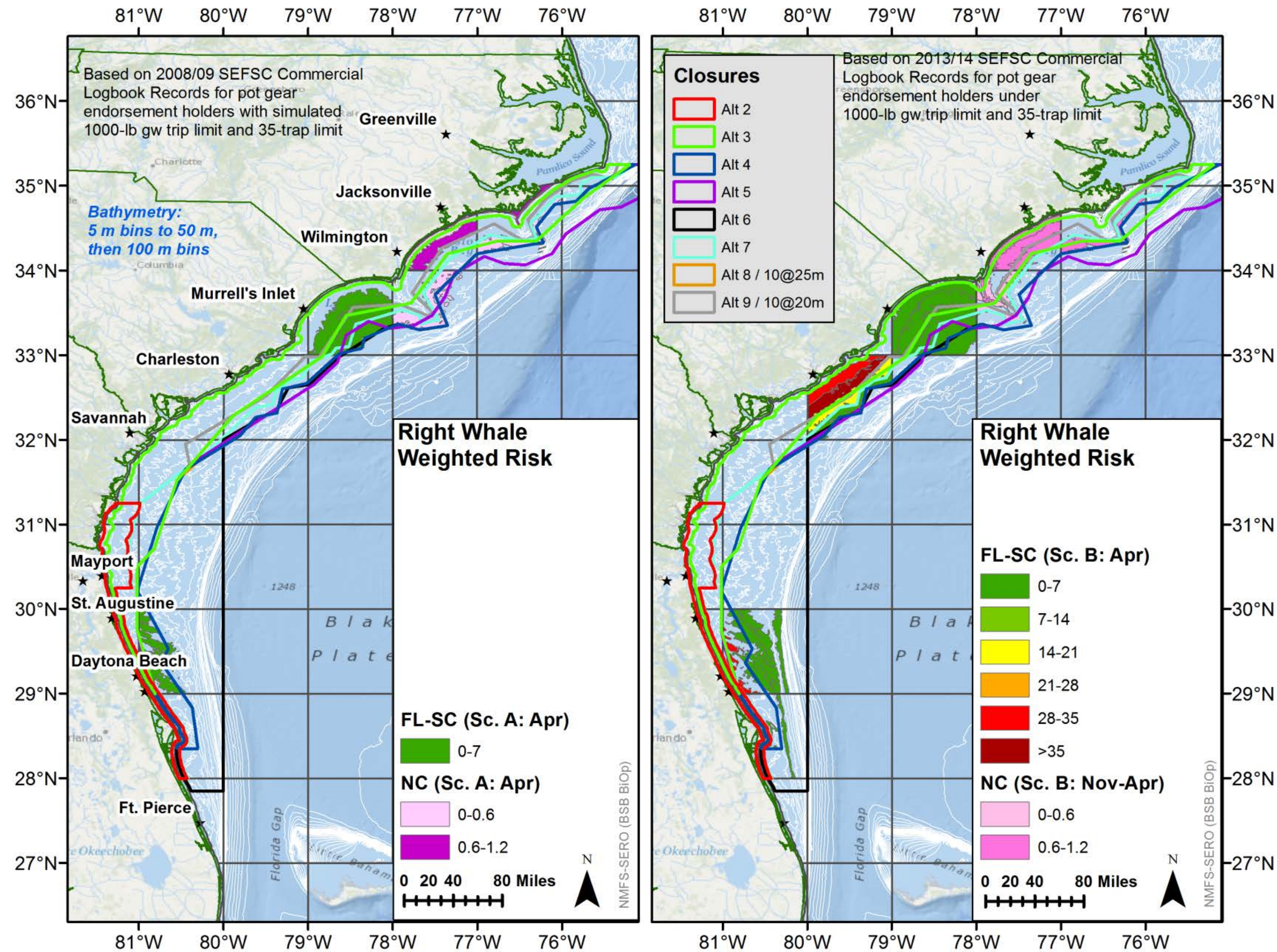


Figure 8F: April

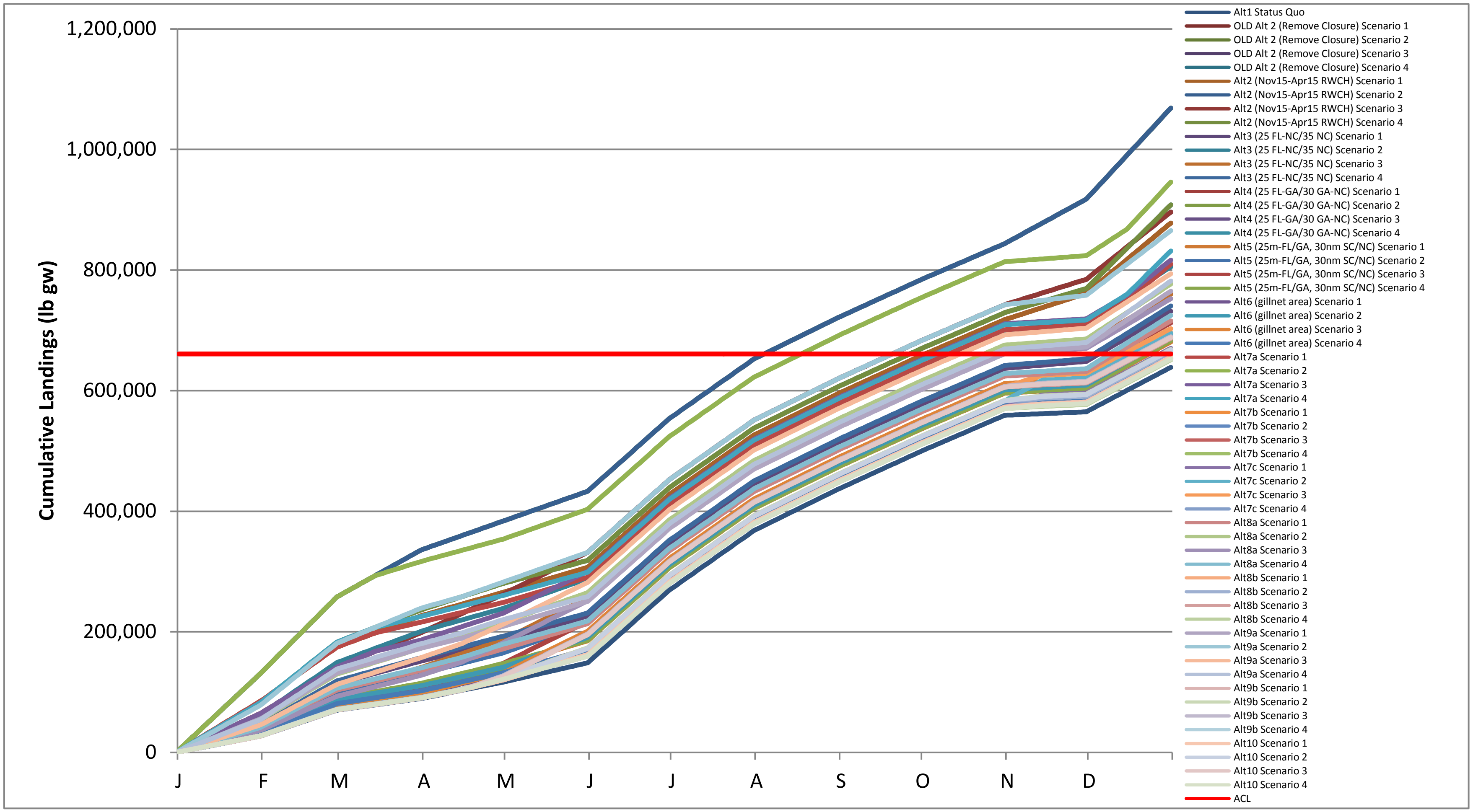


Figure 9. Cumulative landings forecasts for the commercial black sea bass fishery (all gears) under different Regulatory Amendment 16 spatial closure alternatives and different catch rate assumptions (Scenario 1: Observed 2008/09 Nov-Apr catch rates, Scenario 2: Observed 2013/14 catch rates scaled to account for historically higher Nov-Apr catch rates, Scenario 3: Observed 2013/14 catch rates, and Scenario 4: Observed mean 2006/07-2008/09 Nov-Apr catch rates), assuming A) winter 2008/09, B) summer 2013/14, and C) mean of winters 2006/07-2008/09 distribution of pot gear during any fishing in November-April. All figures assume right whale distribution under mean conditions.

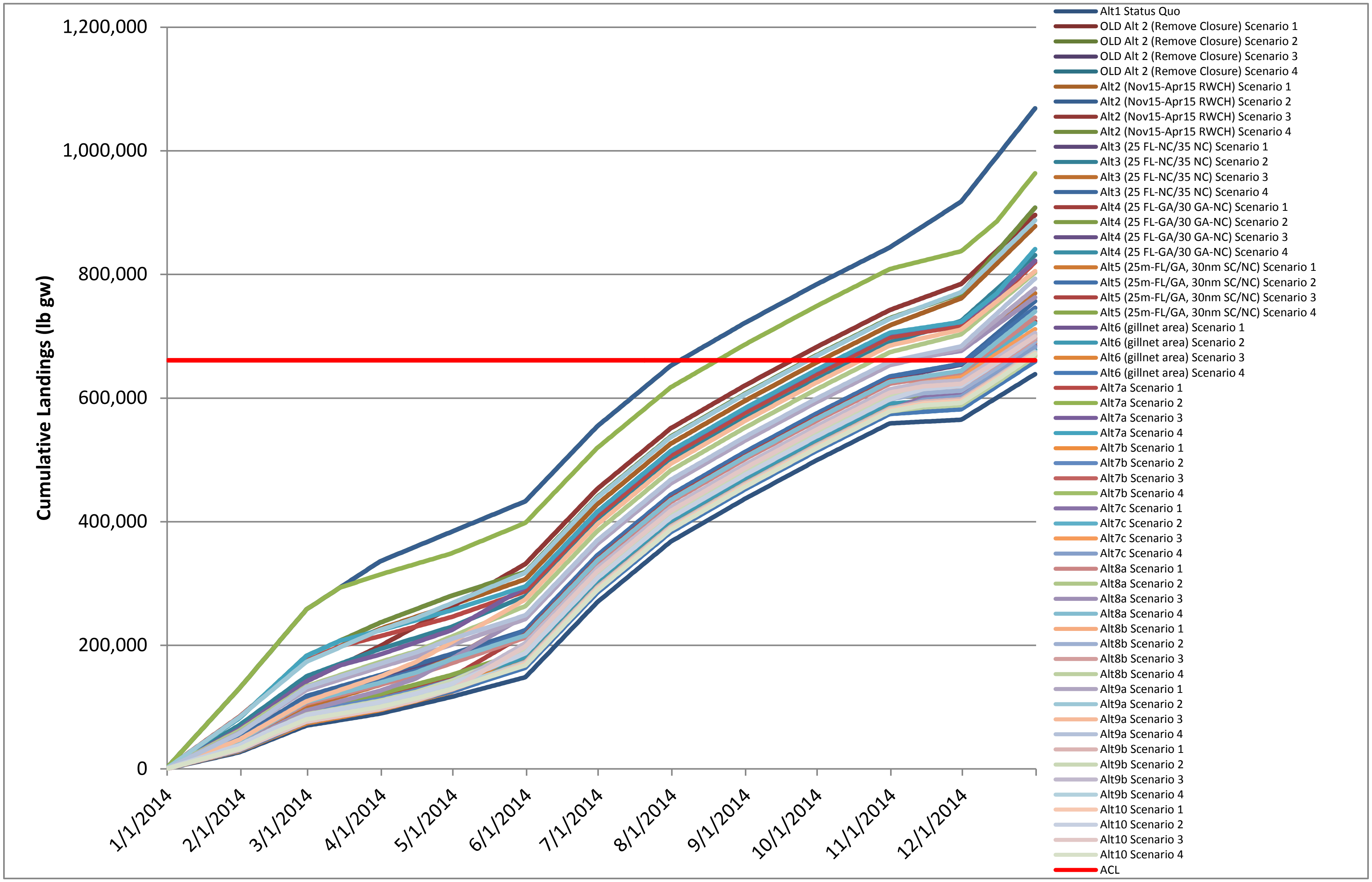
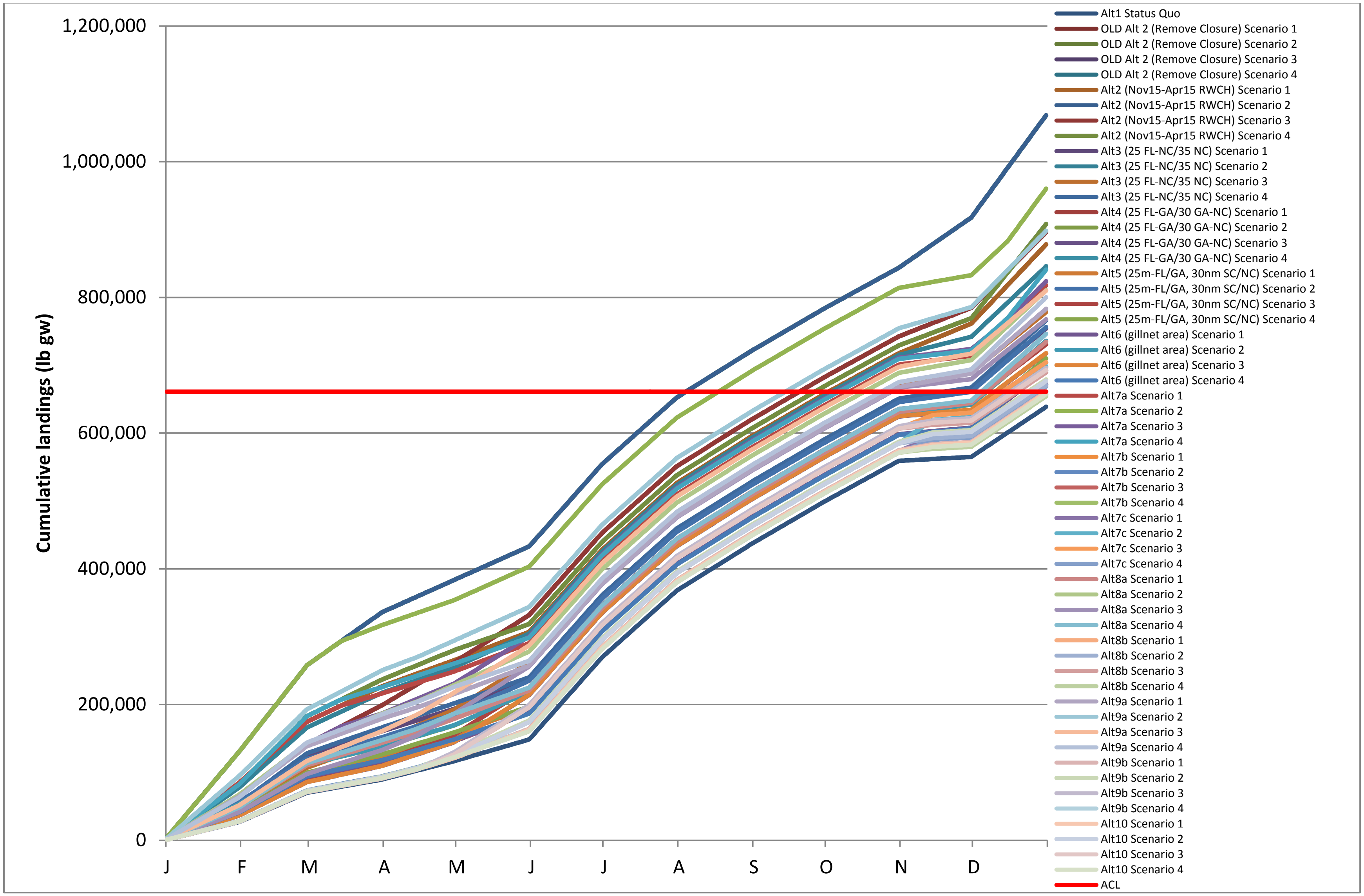

1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Cumulative Landings (lb gw)
1/1/2014
2/1/2014
3/1/2014
4/1/2014
5/1/2014
6/1/2014
7/1/2014
8/1/2014
9/1/2014
10/1/2014
11/1/2014
12/1/2014
Alt1 Status Quo
OLD Alt 2 (Remove Closure) Scenario 1
OLD Alt 2 (Remove Closure) Scenario 2
OLD Alt 2 (Remove Closure) Scenario 3
OLD Alt 2 (Remove Closure) Scenario 4
Alt2 (Nov15-Apr15 RWCH) Scenario 1
Alt2 (Nov15-Apr15 RWCH) Scenario 2
Alt2 (Nov15-Apr15 RWCH) Scenario 3
Alt2 (Nov15-Apr15 RWCH) Scenario 4
Alt3 (25 FL-NC/35 NC) Scenario 1
Alt3 (25 FL-NC/35 NC) Scenario 2
Alt3 (25 FL-NC/35 NC) Scenario 3
Alt3 (25 FL-NC/35 NC) Scenario 4
Alt4 (25 FL-GA/30 GA-NC) Scenario 1
Alt4 (25 FL-GA/30 GA-NC) Scenario 2
Alt4 (25 FL-GA/30 GA-NC) Scenario 3
Alt4 (25 FL-GA/30 GA-NC) Scenario 4
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 1
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 2
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 3
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 4
Alt6 (gillnet area) Scenario 1
Alt6 (gillnet area) Scenario 2
Alt6 (gillnet area) Scenario 3
Alt6 (gillnet area) Scenario 4
Alt7a Scenario 1
Alt7a Scenario 2
Alt7a Scenario 3
Alt7a Scenario 4
Alt7b Scenario 1
Alt7b Scenario 2
Alt7b Scenario 3
Alt7b Scenario 4
Alt7c Scenario 1
Alt7c Scenario 2
Alt7c Scenario 3
Alt7c Scenario 4
Alt8a Scenario 1
Alt8a Scenario 2
Alt8a Scenario 3
Alt8a Scenario 4
Alt8b Scenario 1
Alt8b Scenario 2
Alt8b Scenario 3
Alt8b Scenario 4
Alt9a Scenario 1
Alt9a Scenario 2
Alt9a Scenario 3
Alt9a Scenario 4
Alt9b Scenario 1
Alt9b Scenario 2
Alt9b Scenario 3
Alt9b Scenario 4
Alt10 Scenario 1
Alt10 Scenario 2
Alt10 Scenario 3
Alt10 Scenario 4
ACL

Figure 9B.



1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Cumulative landings (lb gw)
J
F
M
A
M
J
J
A
S
O
N
D
Alt1 Status Quo
OLD Alt 2 (Remove Closure) Scenario 1
OLD Alt 2 (Remove Closure) Scenario 2
OLD Alt 2 (Remove Closure) Scenario 3
OLD Alt 2 (Remove Closure) Scenario 4
Alt2 (Nov15-Apr15 RWCH) Scenario 1
Alt2 (Nov15-Apr15 RWCH) Scenario 2
Alt2 (Nov15-Apr15 RWCH) Scenario 3
Alt2 (Nov15-Apr15 RWCH) Scenario 4
Alt3 (25 FL-NC/35 NC) Scenario 1
Alt3 (25 FL-NC/35 NC) Scenario 2
Alt3 (25 FL-NC/35 NC) Scenario 3
Alt3 (25 FL-NC/35 NC) Scenario 4
Alt4 (25 FL-GA/30 GA-NC) Scenario 1
Alt4 (25 FL-GA/30 GA-NC) Scenario 2
Alt4 (25 FL-GA/30 GA-NC) Scenario 3
Alt4 (25 FL-GA/30 GA-NC) Scenario 4
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 1
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 2
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 3
Alt5 (25m-FL/GA, 30nm SC/NC) Scenario 4
Alt6 (gillnet area) Scenario 1
Alt6 (gillnet area) Scenario 2
Alt6 (gillnet area) Scenario 3
Alt6 (gillnet area) Scenario 4
Alt7a Scenario 1
Alt7a Scenario 2
Alt7a Scenario 3
Alt7a Scenario 4
Alt7b Scenario 1
Alt7b Scenario 2
Alt7b Scenario 3
Alt7b Scenario 4
Alt7c Scenario 1
Alt7c Scenario 2
Alt7c Scenario 3
Alt7c Scenario 4
Alt8a Scenario 1
Alt8a Scenario 2
Alt8a Scenario 3
Alt8a Scenario 4
Alt8b Scenario 1
Alt8b Scenario 2
Alt8b Scenario 3
Alt8b Scenario 4
Alt9a Scenario 1
Alt9a Scenario 2
Alt9a Scenario 3
Alt9a Scenario 4
Alt9b Scenario 1
Alt9b Scenario 2
Alt9b Scenario 3
Alt9b Scenario 4
Alt10 Scenario 1
Alt10 Scenario 2
Alt10 Scenario 3
Alt10 Scenario 4
ACL

Figure 9C.

Figure 10. South Atlantic commercial black sea bass projected closure dates (black dashes) and relative right whale risk of pot gear vertical line entanglement off North Carolina (blue bars) and Florida to South Carolina (green bars) under 2008/09 winter (Scenario A), 2013/14 summer (Scenario B), and mean 2006/07-2008/09 winter (Scenario C) spatial pot distributions for catch rate Scenarios 1-4.

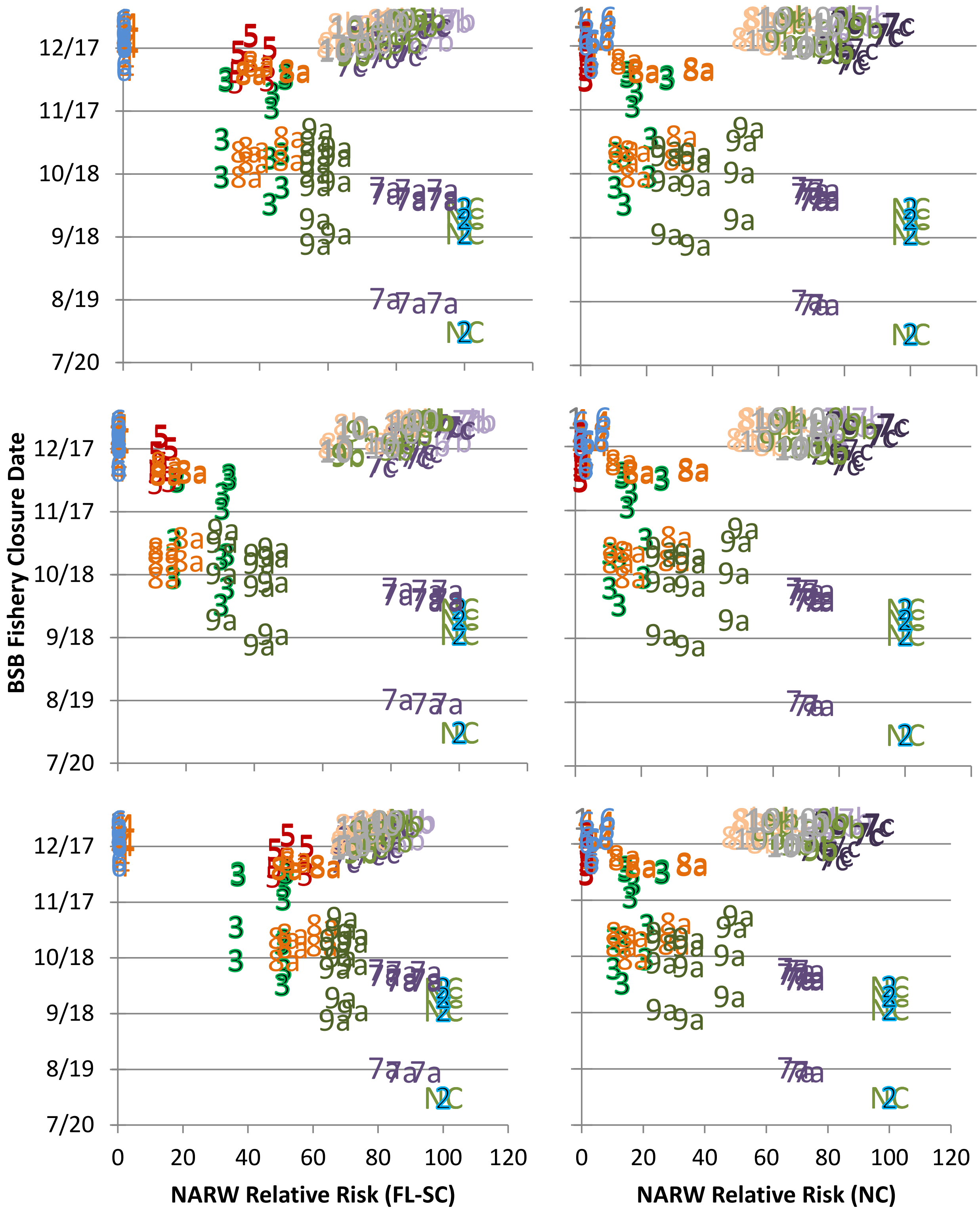


Figure 11. North Atlantic right whale (NARW) relative risk versus projected black sea bass (BSB) fishery closure date, by alternative (colored numbers), across catch rate and spatial pot gear distribution scenarios, for right whale distributions under mean (top), warm (middle), and cold conditions (bottom). Number/letter combinations included in the graphs correspond to alternatives in Reg-16.

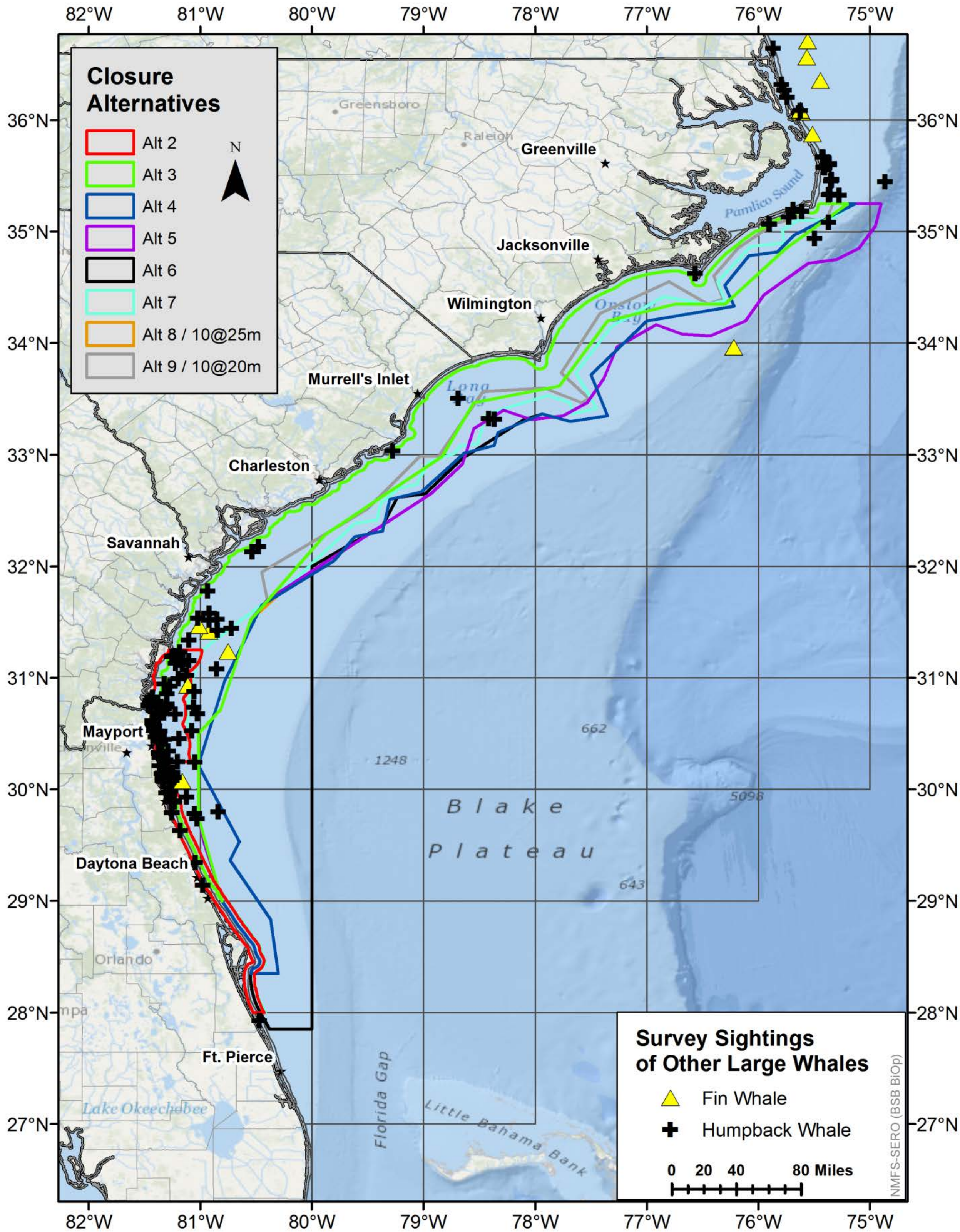


Figure 12. Aerial survey observations (2005-2014) of humpback whales and fin whales within the SAFMC jurisdiction relative to Reg-16 proposed closure alternatives.

APPENDIX A: MANAGEMENT HISTORY

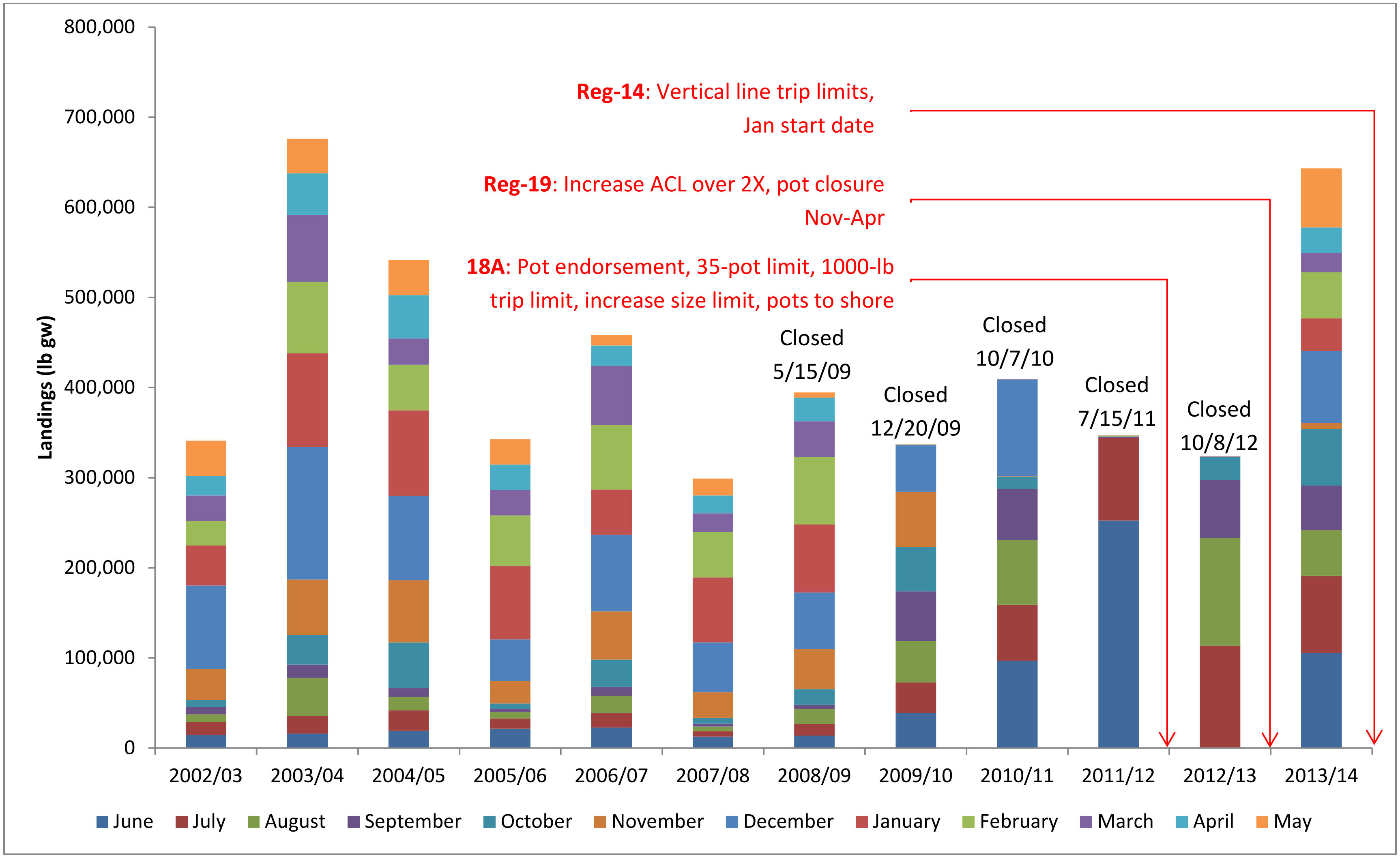


Figure A.1. Commercial black sea bass landings by fishing year and month, relative to management history. Sources: SEFSC Commercial ACL Data (July 2014) and SEFSC Trip Ticket Data (Sept 2014 – for the 2013/14 season).

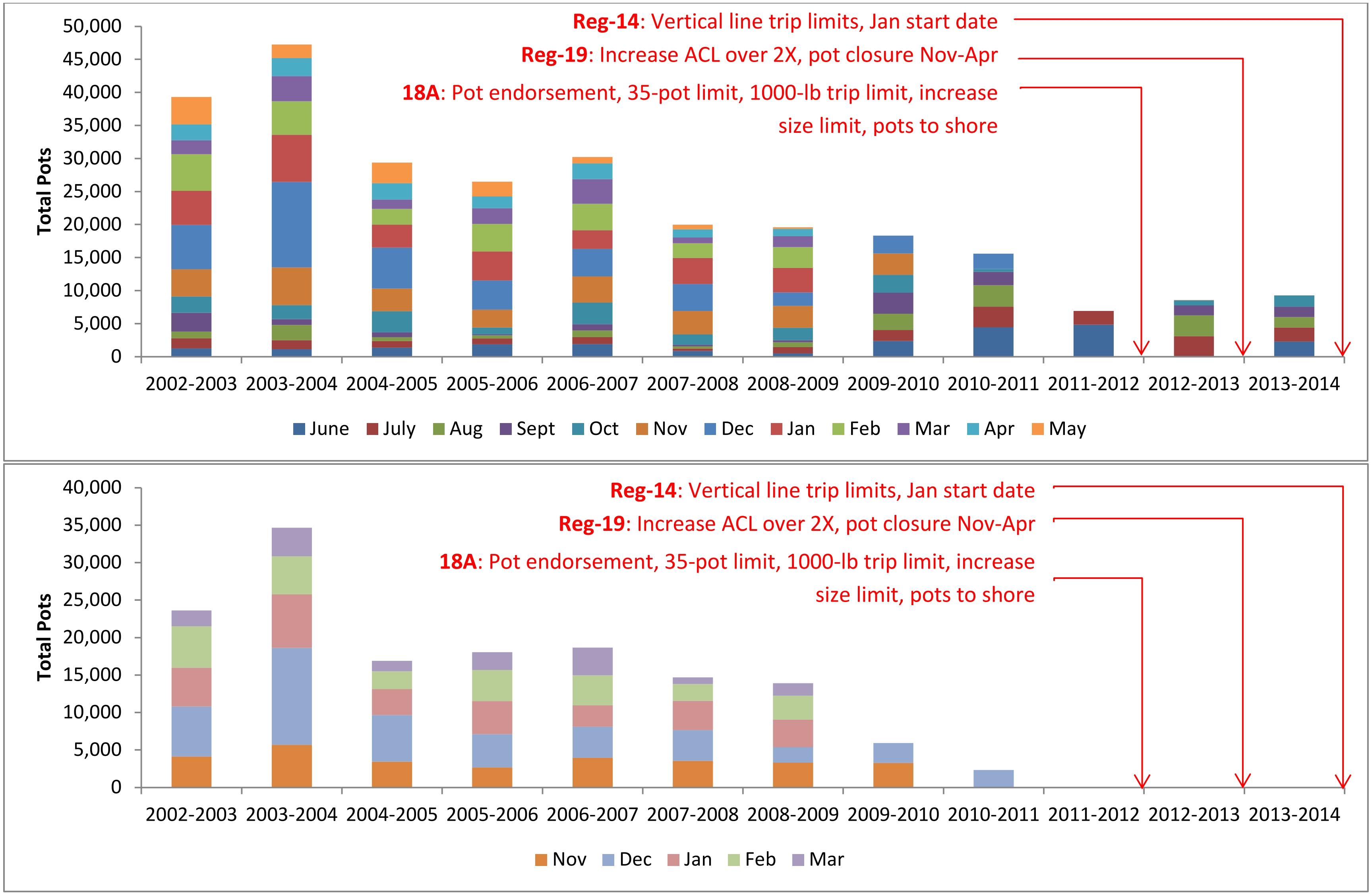


Figure A.2. Commercial black sea bass effort (number of pots) by fishing year and month, relative to management history for full season (top) and winter only (bottom). Sources: SEFSC Commercial Logbook Data (July 2014).

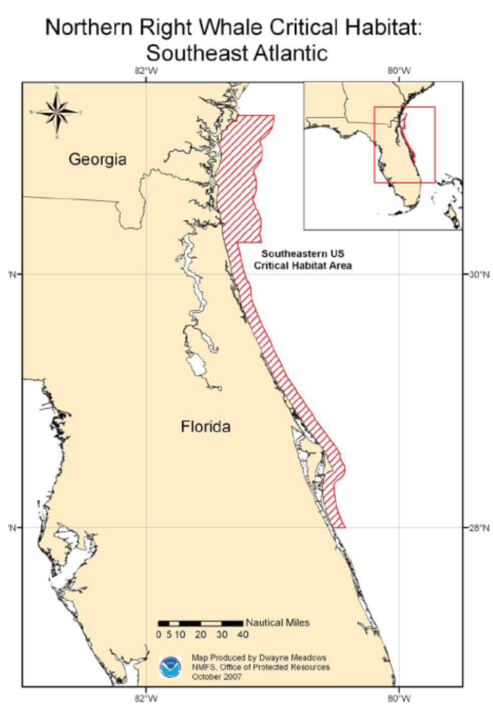
APPENDIX B: REG-16 CLOSURE ALTERNATIVES

Highlighting denotes areas where Council clarification is needed.

Alternative 1 (No Action). Retention, possession, and fishing for black sea bass is prohibited using black sea bass pot gear, annually, from November 1 through April 30.

Alternative 2. The black sea bass pot closure applies to the area currently designated as North Atlantic right whale critical habitat (Figure B2.1.1). North Atlantic right whale critical habitat encompasses waters between 31° 15'N, (approximately the mouth of the Altamaha River, Georgia) and 30° 15'N (approximately Jacksonville, Florida) from the shoreline out to 15 nautical miles offshore; and the waters between 30° 15'N and 28 °00'N, (approximately Sebastian Inlet, Florida) from the shoreline out to 5 nautical miles. The closure applies to the area annually from November 15 through April 15.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations within state waters.



Note: This area represents North Atlantic right whale critical habitat in the South Atlantic region designated on June 3, 1994. The map below provides location of the critical habitat boundary. The critical habitat designation did not provide waypoints for the boundary. The boundary would not automatically change if the boundary for the right whale critical habitat were to change.

Figure B2.1.1. Area for the proposed black sea bass pot closure in Alternative 2.

The following is language describing the North Atlantic right whale critical habitat area from 50 CFR 226: "Southeastern United States: The area designated as critical habitat in these waters encompasses waters between 31 deg.15'N (approximately located at the mouth of the Altamaha River, GA) and 30 deg.15'N (approximately Jacksonville, FL) from the shoreline out to 15 nautical miles offshore; and the waters between 30 deg.15'N and 28 deg.00'N (approximately Sebastian Inlet, FL) from the shoreline out to 5 nautical miles." Note: North Atlantic right whale critical habitat is currently undergoing a revision based on more current data. Proposed changes are published at 80 FR 9313.

Alternative 3. The black sea bass pot closure applies to waters inshore of points 1-15 listed below (Table B2.1.1); approximately Ponce Inlet, Florida, to Cape Hatteras, North Carolina (Figure B2.1.2). The closure applies to the area annually from November 1 through April 30.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations within state waters.

Note: This area likely represents North Atlantic right whale calving habitat. The area identified from Cape Fear, North Carolina, southward to 29°N (approximately Ponce Inlet, Florida) is based on model outputs (i.e., Garrison 2007, Keller et al. 2012, Good 2008). The area from Cape Fear, North Carolina, to Cape Hatteras, North Carolina, is an extrapolation of those model outputs and based on sea surface temperatures and bathymetry.

Table B2.1.1. Eastern boundary coordinates for proposed black sea bass pot closure in Alternative 3.

Point	N Latitude	W Longitude
1	35°15′ N	State/EEZ boundary
2	35°15'	75°12'
3	34°51'	75°45'
4	34°21'	76°18'
5	34°21'	76°45'
6	34°12'	77°21'
7	33°37'	77°47
8	33°28'	78°33
9	32°59'	78°50'
10	32°17'	79°53'
11	31°31'	80°33'
12	30°43'	80°49'
13	30°30'	81°01'
14	29°45'	81°01'
15	29°00'	State/EEZ boundary

Note that federal regulations would only include the waters of the South Atlantic EEZ. The states will be asked to comply by implementing complementary regulations in state waters.

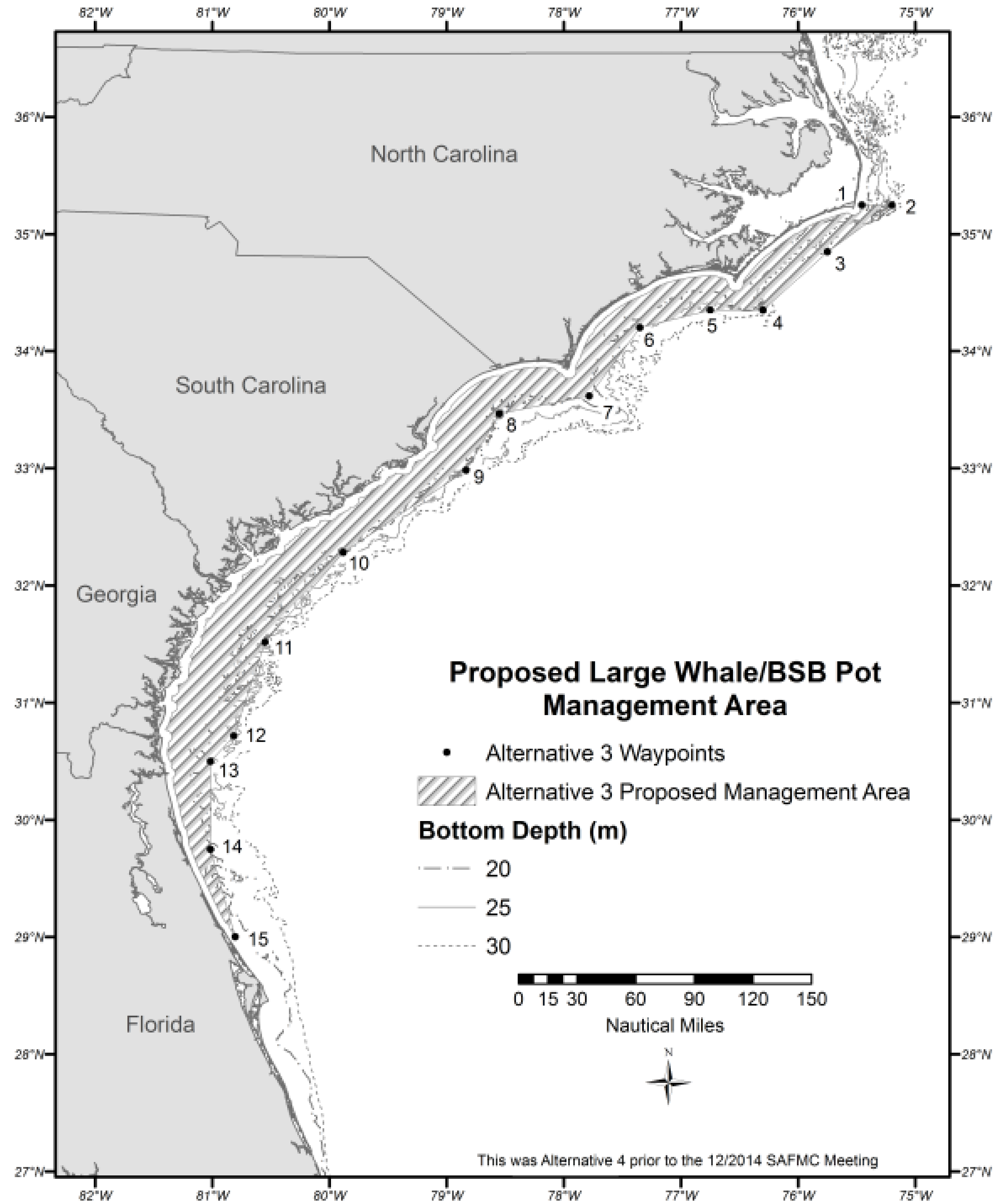


Figure B2.1.2. Area for the proposed black sea bass pot closure in Alternative 3.

Alternative 4. The black sea bass pot closure applies to waters inshore of points 1-28 listed below (Table B2.1.2), approximately Cape Canaveral, Florida, to Cape Hatteras, North Carolina (Figure B2.1.3). The closure applies to the area annually from November 1 through April 30.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations within state waters.

Note: This area generally represents waters 25 m or shallower from 28° 21 N (approximately Cape Canaveral, Florida) to Savannah, Georgia; from the Georgia/South Carolina border to Cape Hatteras, North Carolina, the closure applies to waters under Council management that are 30 m or shallower. This bathymetric area is based on right whale sightings (all demographic segments) and sightings per unit of effort (proxy of density) by depth and captures 97% and 96% of right whale sightings off the North Carolina/South Carolina area, and Florida/Georgia area, respectively. The map below provides an approximate location of the proposed boundary.

Table B2.1.2. Eastern boundary coordinates for proposed black sea bass pot closure in Alternative 4.

Point	N Latitude	W Longitude
1	35° 15’	State/EEZ boundary
2	35° 15’	75° 08’
3	34° 58’	75° 41’
4	34° 49’	75° 50’
5	34° 47’	76° 05’
6	34° 31’	76° 18’
7	34° 20’	76° 13
8	34° 12’	77° 00’
9	33° 43’	77° 30’
10	33° 21’	77° 21’
11	33° 18’	77° 41’
12	33° 22’	77° 56’
13	33° 12’	78° 20’
14	33° 05’	78° 22’
15	33° 01’	78° 38’
16	32° 40’	79° 01’
17	32° 36’	79° 18’
18	32° 19’	79° 22’
19	32° 16’	79° 37’
20	32° 03’	79° 48’
21	31° 39’	80° 27’
22	30° 58’	80° 47’
23	30° 13’	81° 01’
24	29° 32’	80° 39’
25	29° 22’	80° 44’
26	28° 50’	80° 22’
27	28° 21’	80° 18’
28	28° 21’	State/EEZ boundary

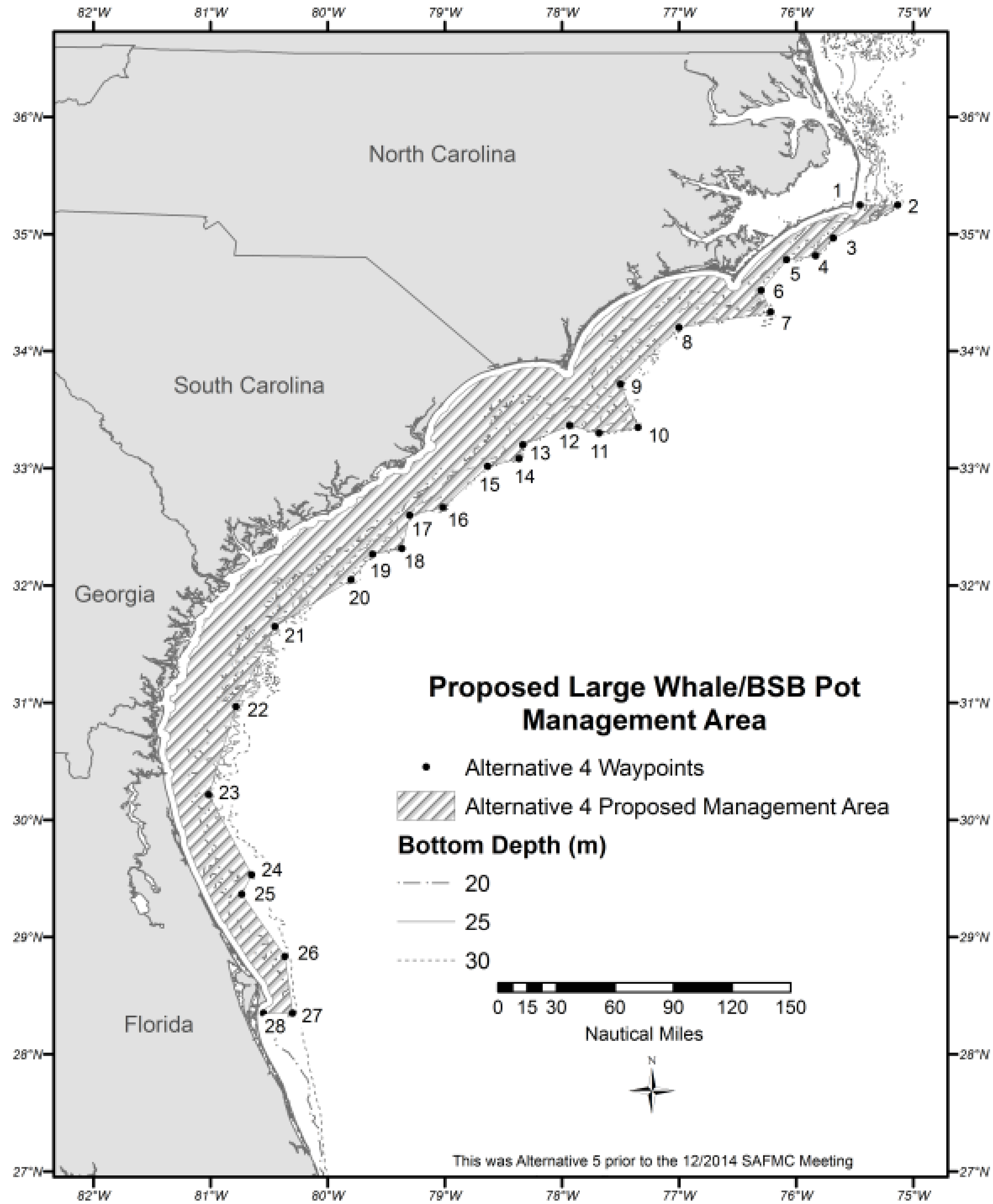


Figure B2.1.3. Area for the proposed black sea bass pot closure in Alternative 4.

Alternative 5. The black sea bass pot closure applies to waters inshore of points 1-28 listed below (Table B2.1.3); approximately Daytona Beach, Florida, to Cape Hatteras, North Carolina (Figure B2.1.4). The closure applies to the area annually from November 1 through April 30.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations within state waters.

Note: This area is based on joint comments received from non-government organizations (dated January 3, 2014) in response to NMFS' December 4, 2013, Federal Register Notice of Intent to Prepare this Draft Environmental Impact Statement (DEIS) (78 FR 72868). The non-government organizations proposed the area as a reasonable alternative for consideration. The area, also included in a Center for Biological Diversity et al. petition in 2009 for right whale critical habitat, is off the coasts of Georgia and Florida and based on calving right whale habitat modeling work of Garrison (2007) and Keller et al. (2012). This area represents the 75th percentile of sightings (91% of historical sightings included in their study) off Florida and Georgia (Garrison 2007 and Keller et al. 2012). Off the coasts of North Carolina and South Carolina, the closure extends from the coastline to 30 nautical miles offshore. The map below provides approximate location of proposed boundary.

Table B2.1.3. Eastern boundary coordinates for proposed black sea bass pot closure in Alternative 5.

Point	N Latitude	W Longitude
1	35°15'	State/EEZ Boundary
2	35°15'	74°54'
3	35°03'	74°57'
4	34°51'	75°06'
5	34°45'	75°18'
6	34°43'	75°33'
7	34°26'	75°57'
8	34°12'	76°07'
9	34°04'	76°26'
10	34°05'	76°41'
11	34°10'	76°55'
12	33°58'	77°16'
13	33°41'	77°23'
14	33°28'	77°32'
15	33°21'	77°45'
16	33°19'	78°02'
17	33°24'	78°17'
18	33°14'	78°33'
19	32°55'	78°39'
20	32°39'	78°56'
21	31°42'	80°24'
22	31°31'	80°33'
23	30°43'	80°49'
24	30°30'	81°01'
25	29°45'	81°01'
26	29°31'	80°58'
27	29°13'	80°52'
28	29°13'	State/EEZ boundary

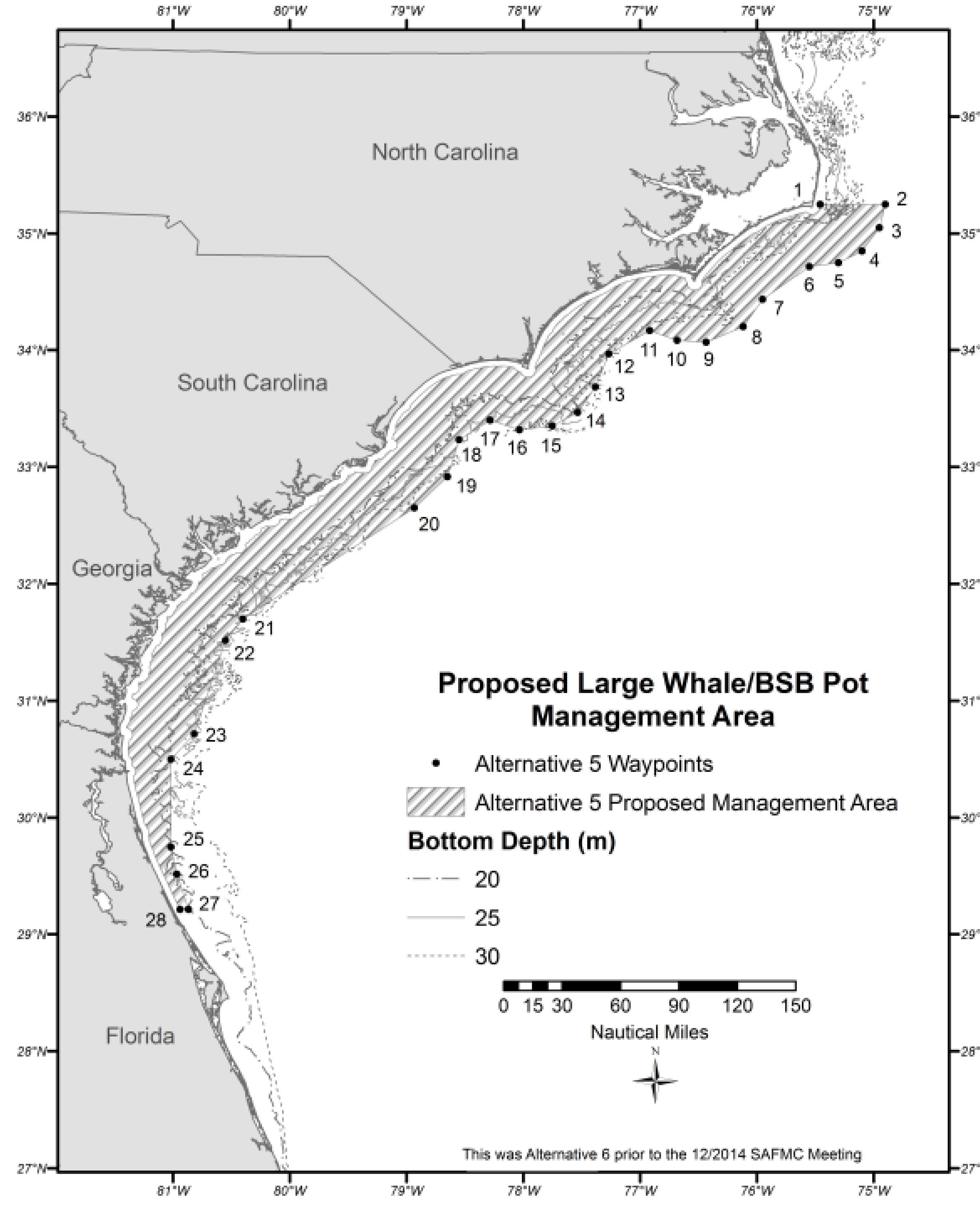


Figure B2.1.4. Area for the proposed black sea bass pot closure in Alternative 5.

Alternative 6. The black sea bass pot closure applies to waters inshore of points 1-20 listed below (Table 2.1.4), approximately Sebastian, Florida, to Cape Hatteras, North Carolina. The closure applies to the area annually from November 1 through April 30.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations within state waters.

Note: This area is also based on joint comments received from a number of environmental groups (dated January 3, 2014) in response to NMFS' December 4, 2013, Federal Register Notice of Intent to Prepare this DEIS (78 FR 72868). The environmental groups proposed the area as a reasonable alternative for consideration. This area represents an existing management area, the Southeast Seasonal Gillnet Restricted Area, under the ALWTRP; and an additional area off North Carolina. The area off North Carolina includes waters shallower than 30 meters and is northward of the designated ALWTRP Southeast Restricted Area.

Table B2.1.4. Eastern boundary coordinates for the proposed black sea bass pot closure in Alternative 6.

Point	N. Latitude	W Longitude
1	35º 15'	State/EEZ Boundary
2	35º 15'	75º 08'
3	34º 58'	75º 41'
4	34º 49'	75º 50'
5	34º 47'	76º 05'
6	34º 31'	76º 18'
7	34º 20'	76º 13'
8	34º 12'	77º 00'
9	33º 43'	77º 30'
10	33º 21'	77º 21'
11	33º 18'	77º 41'
12	33º 22'	77º 56'
13	33º 19'	78º 06'
14	32º 58'	78º 39'
15	32º 39'	78º 59'
16	32º 37'	79º 14'
17	32º 22'	79º 22'
18	32º 00'	80º 00'
19	27º 51'	80º 00'
20	27º 51'	State/EEZ Boundary

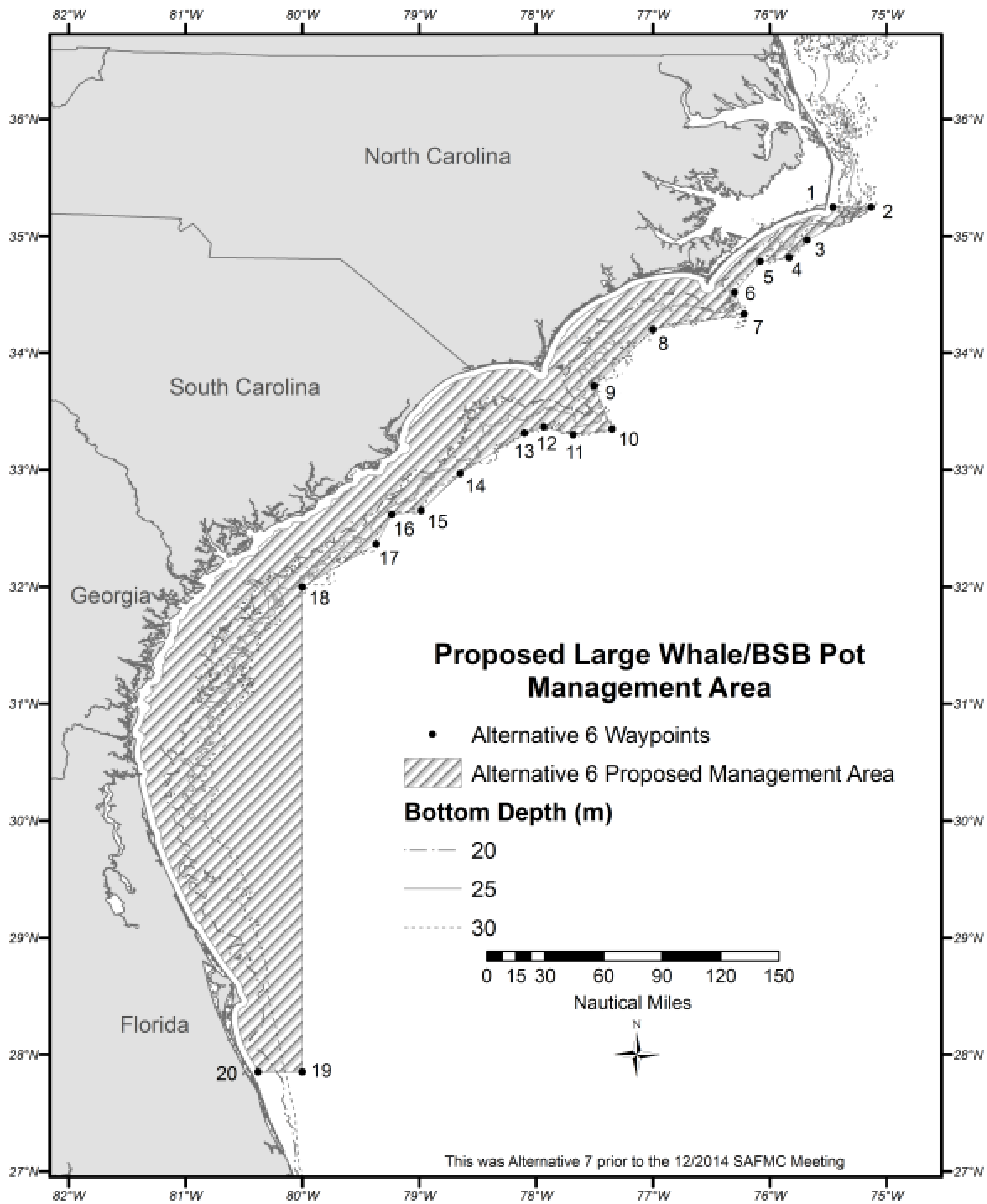


Figure B2.1.5. Area for the proposed black sea bass pot closure in Alternative 6.

Alternative 7. The black sea bass pot closure applies to the area currently designated as North Atlantic right whale critical habitat, in addition to waters inshore of points 1-29 listed below (Table B2.1.5), approximately North of the Altamaha River, Georgia, to Cape Hatteras, North Carolina (Figure B2.1.6).

> *Sub-alternative 7a.* The black sea bass pot closure applies to the area annually from November 1 through December 15 and March 15 through April 30.
>
> *Sub-alternative 7b.* For the area off North Carolina and South Carolina, the black sea bass pot closure applies annually from November 1 through December 15 and March 15 through April 30. For the area off Georgia and Florida, the black sea bass pot closure applies annually from November 15 through April 15.
>
> *Sub-alternative 7c.* For the area off North Carolina and South Carolina, the black sea bass pot closure applies annually from February 15 through April 30. For the area off Georgia and Florida, the black sea bass pot closure applies annually from November 15 through April 15.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations for the portion of the area within state waters.

Note: This area represents North Atlantic right whale critical habitat in the South Atlantic region designated on June 3, 1994. However, the closure dates are inconsistent with the critical habitat listing since right whales inhabit southeastern waters from 1 Nov-30 Apr. Off North Carolina and South Carolina, the black sea bass pot closure applies in the exclusive economic zone in waters shallower than 25 meters. The eastern boundary of the closure between these two areas was formed by drawing a straight line from the southeastern corner waypoint of the northern portion (NC/SC) to the northeastern corner waypoint of the southern section (FL/GA).

The following is language describing the North Atlantic right whale critical habitat area from 50 CFR 226:

Southeastern United States: The area designated as critical habitat in these waters encompasses waters between 31 deg.15'N (approximately located at the mouth of the Altamaha River, GA) and 30 deg.15'N (approximately Jacksonville, FL) from the shoreline out to 15 nautical miles offshore; and the waters between 30 deg.15'N and 28 deg.00'N (approximately Sebastian Inlet, FL) from the shoreline out to 5 nautical miles.

Table B2.1.5. Eastern boundary coordinates for proposed black sea bass pot closure Alternative 7.

Point	N. Latitude	W Longitude
1	35° 15'	State/EEZ boundary
2	35° 15'	75° 09'
3	35° 06'	75° 22'
4	35° 06'	75° 39'
5	35° 01'	75° 47'
6	34° 54'	75° 46'
7	34° 52'	76° 04'
8	34° 33'	76° 22'
9	34° 23'	76° 18'
10	34° 21'	76° 27'
11	34° 25'	76° 51'
12	34° 09'	77° 19'
13	33° 44'	77° 38'
14	33° 25'	77° 27'
15	33° 22'	77° 40'
16	33° 28'	77° 41'
17	33° 32'	77° 53'
18	33° 22'	78° 26'
19	33° 06'	78° 31'
20	33° 05'	78° 40'
21	33° 01'	78° 43'
22	32° 56'	78° 57'
23	32° 44'	79° 04'
24	32° 42'	79° 13'
25	32° 34'	79° 23'
26	32° 25'	79° 25'
27	32° 23'	79° 37'
28	31° 53'	80° 09'
29	31° 15'	80° 59'
30	30° 56'	81° 05'
31	30° 42'	81° 07'
32	30° 15'	81° 05'
33	30° 15'	81° 17'
34	29° 40'	81° 07'
35	29° 08'	80° 51'
36	28° 36'	80° 28'
37	28° 26'	80° 25'
38	28° 20'	80° 31'
39	28° 11'	80° 30'
40	28° 00'	80° 25'
41	28° 00'	State/EEZ Boundary

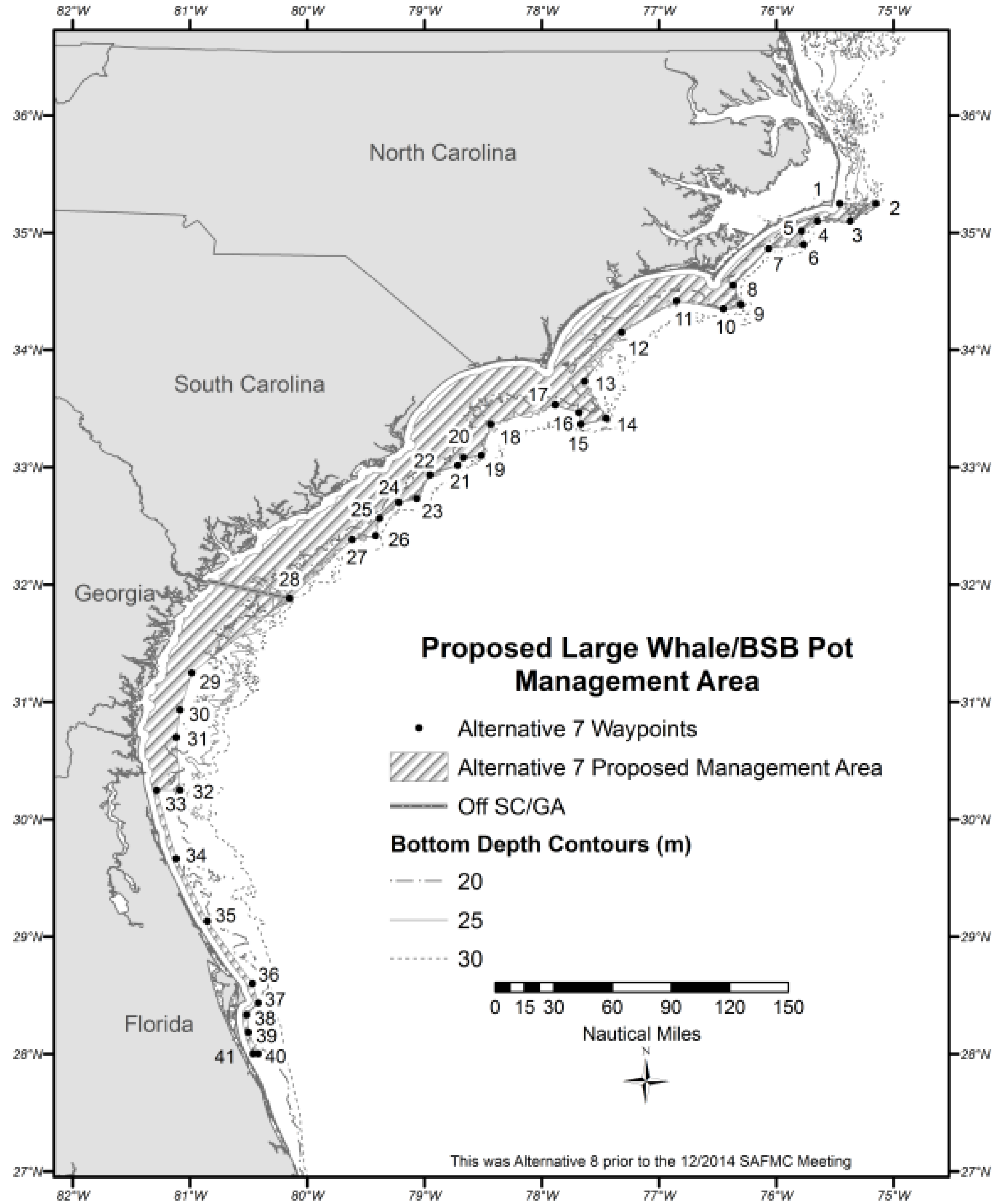


Figure B2.1.6. Area for the proposed black sea bass pot closure in Alternative 7.

Alternative 8. The black sea bass pot closure applies to waters inshore of points 1-35 listed below (Table B2.1.6), approximately Daytona Beach, Florida, to Cape Hatteras, North Carolina (Figure B2.1.7).

> *Sub-alternative 8a.* The black sea bass pot closure applies to the area annually from November 1 through April 15.
>
> *Sub-alternative 8b.* For the area off North Carolina and South Carolina, the black sea bass pot closure applies annually from November 1 through December 15 and February 15 through April 30. For the area off Georgia and Florida, the black sea bass pot closure applies annually from November 15 through April 15.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations for the portion of the area within state waters.

Note: In Alternative 8, the boundaries off Florida and Georgia are identical to the boundaries in Alternative 5. Off North Carolina and South Carolina, the black sea bass pot closure applies in the exclusive economic zone in waters shallower than 25 meters.

Table B2.1.6. Eastern boundary coordinates for proposed black sea bass pot closure in Alternative 8.

Point	N. Latitude	W Longitude
1	35° 15'	State/EEZ Boundary
2	35° 15'	75° 09'
3	35° 06'	75° 22'
4	35° 06'	75° 39'
5	35° 01'	75° 47'
6	34° 54'	75° 46'
7	34° 52'	76° 04'
8	34° 33'	76° 22'
9	34° 23'	76° 18'
10	34° 21'	76° 27'
11	34° 25'	76° 51'
12	34° 09'	77° 19'
13	33° 44'	77° 38'
14	33° 25'	77° 27'
15	33° 22'	77° 40'
16	33° 28'	77° 41'
17	33° 32'	77° 53'
18	33° 22'	78° 26'
19	33° 06'	78° 31'
20	33° 05'	78° 40'
21	33° 01'	78° 43'
22	32° 56'	78° 57'
23	32° 44'	79° 04'
24	32° 42'	79° 13'
25	32° 34'	79° 23'
26	32° 25'	79° 25'
27	32° 23'	79° 37
28	31° 53'	80° 09'
29	31º 31'	80º 33'
30	30º 43'	80º 49'
31	30º 30'	81º 01'
32	29º 45'	81º 01'
33	29º 31'	80º 58'
34	29º 13'	80º 52'
35	29º 13'	State/EEZ Boundary

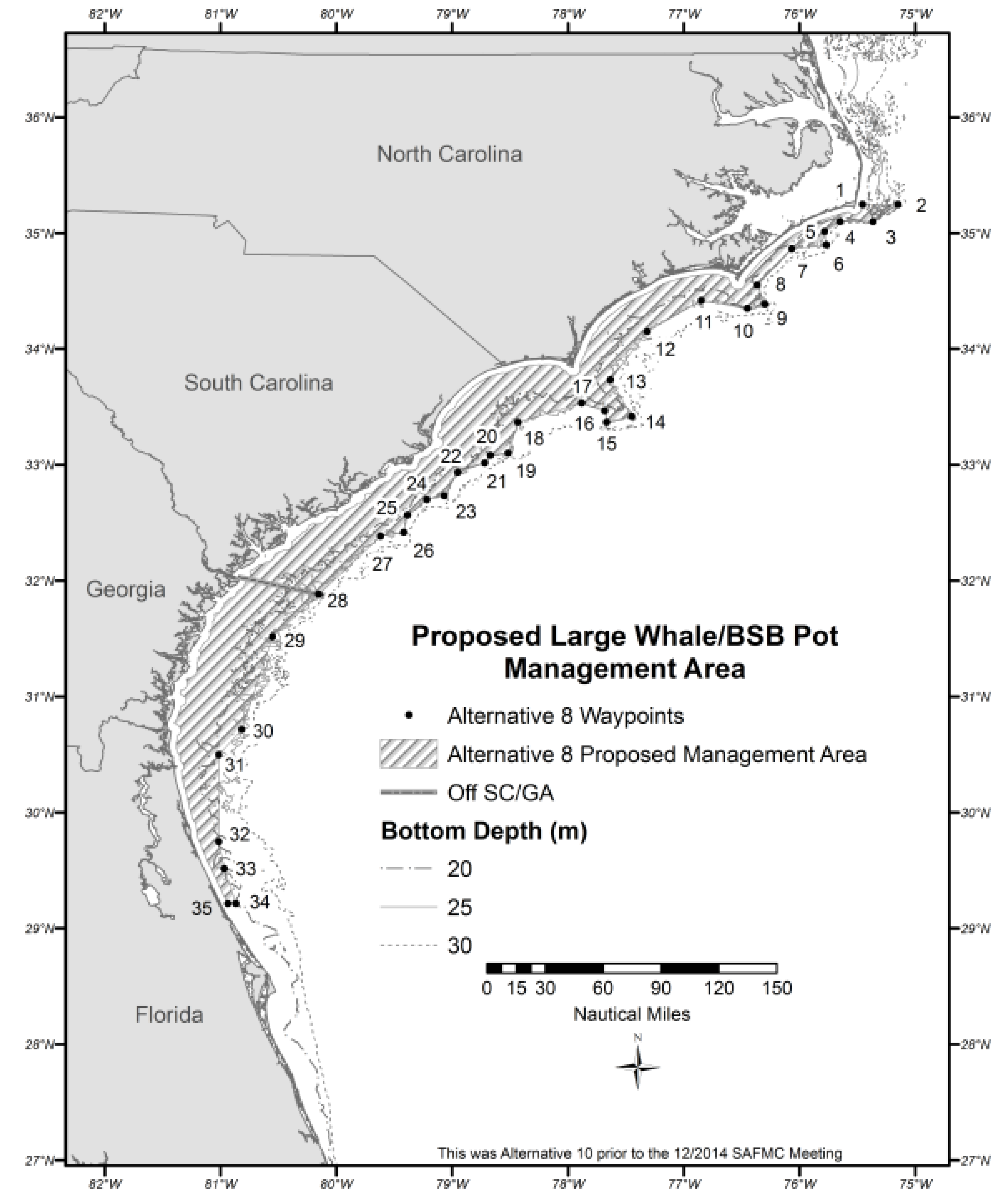


Figure B2.1.7. Area for the proposed black sea bass pot closure in Alternative 8.

Alternative 9 . The black sea bass pot closure applies to waters inshore of points 1-18 listed below (Table B2.1.7), approximately Daytona Beach, Florida, to Cape Hatteras, North Carolina (Figure B2.1.8).

> *Sub-alternative 9a.* The black sea bass pot closure applies to the area annually from November 1 through April 15.
>
> *Sub-alternative 9b.* For the area off North Carolina and South Carolina, the black sea bass pot closure applies annually from November 1 through December 15 and February 15 through April 30. For the area off Georgia and Florida, the black sea bass pot closure applies annually from November 15 through April 15.

Note: Federal regulations would only apply to that portion of the area within the South Atlantic EEZ. The states will be asked to implement compatible regulations for the portion of the area within state waters.

Note: In Alternative 9, the boundaries off Florida and Georgia are identical to the boundaries in Alternative 5. Off North Carolina and South Carolina, the black sea bass pot closure applies in the exclusive economic zone in waters shallower than 20 meters.

Table B2.1.7. Eastern boundary coordinates for the proposed black sea bass pot closure in Alternative 9.

Point	N. Latitude	W Longitude
1	35° 15’	State/EEZ Boundary
2	35° 15'	75° 20'
3	35° 05'	75° 24'
4	35° 08'	75° 38'
5	35° 04'	75° 52'
6	34° 51'	76° 11'
7	34° 36'	76° 24'
8	34° 24'	76° 19'
9	34° 21'	76° 27'
10	34° 33'	76° 48'
11	34° 16'	77° 25'
12	33° 44'	77° 46'
13	33° 30'	77° 31'
14	33° 28'	77° 35'
15	33° 36'	77° 55'
16	33° 34'	78° 28'
17	32° 59'	78° 52'
18	32° 59'	79° 02'
19	32° 31'	79° 30'
20	31° 57'	80° 27'
11	31° 42'	80° 24'
12	31º 31'	80º 33'
13	30º 43'	80º 49'
14	30º 30'	81º 01'
15	29º 45'	81º 01'
16	29º 31'	80º 58'
17	29º 13'	80º 52'
18	29º 13'	State/EEZ Boundary

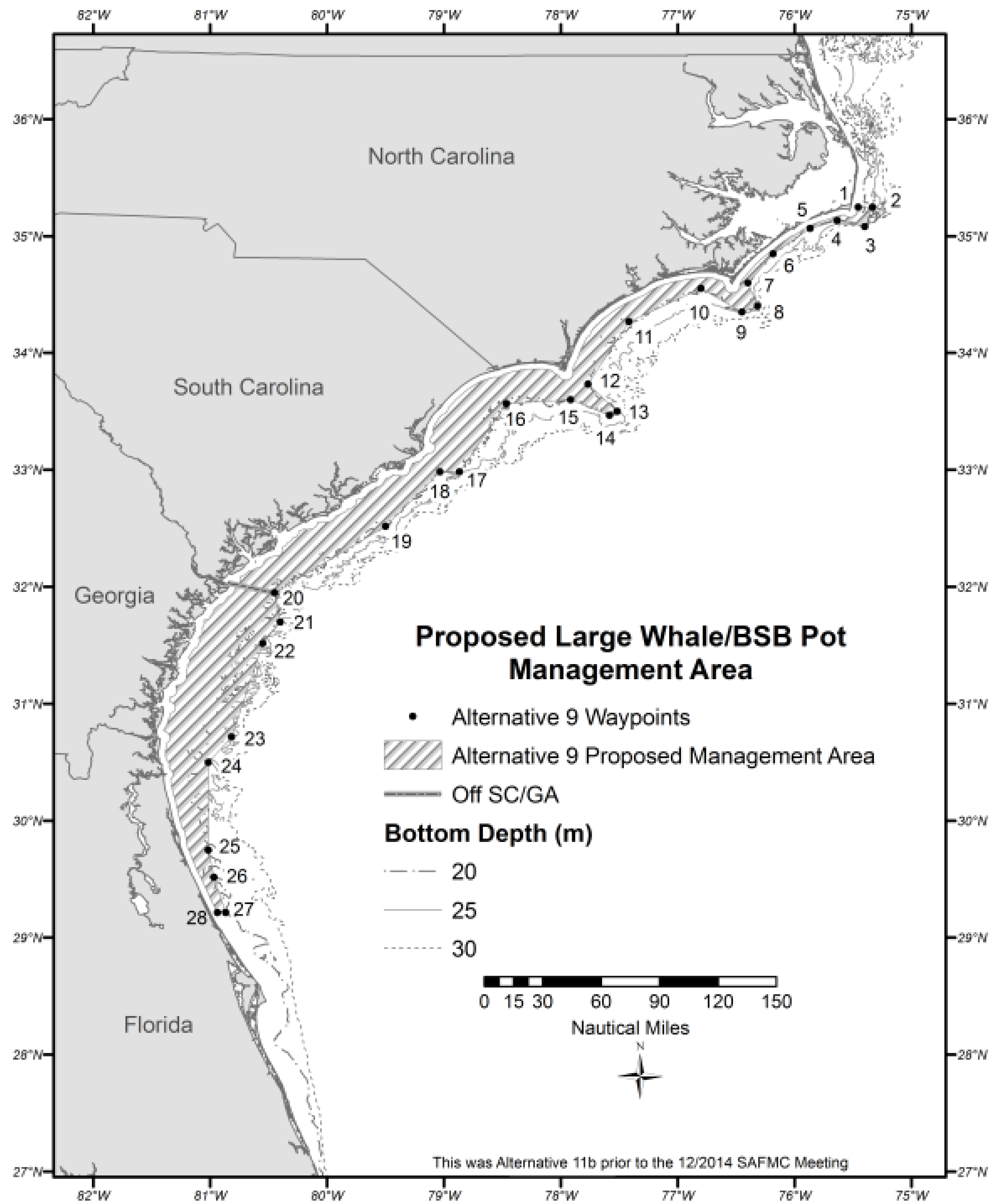


Figure B2.1.8. Area for the proposed black sea bass pot closure in Alternative 9.

Alternative 10. From November 1 through December 15, the black sea bass pot closure applies to waters inshore of points 1-20 listed below **(Table 2.1.8)**, approximately Georgia/South Carolina State Line, to Cape Hatteras, North Carolina **(Figure 2.1.9).**

From February 15 through April 30, the black sea bass pot closure applies to waters inshore of points 1-28 listed below **(Table 2.1.9)**, approximately Georgia/South Carolina State Line, to Cape Hatteras, North Carolina **(Figure 2.1.10).**

From December 16 through February 14, there would be no closure off of the Carolinas.

From November 15 through April 15, the black sea bass pot closure applies to waters inshore of points 20-28 listed below **(Table 2.1.8)**, approximately Georgia/South Carolina State Line, to approximately Daytona Beach, Florida **(Figure 2.1.9).**

Note: In Alternative 10, the boundaries off Florida and Georgia are identical to the boundaries in Alternative 5. Off North Carolina and South Carolina, the black sea bass pot closure applies in the exclusive economic zone in waters shallower than 20 meters from November 1 through x and 25 meters from x through April 30..

Table B2.1.8. Eastern boundary coordinates for the proposed black sea bass pot closure in Alternative 10 for November 1 through x.

Point	N. Latitude	W Longitude
1	35° 15’	State/EEZ Boundary
2	35° 15'	75° 20'
3	35° 05'	75° 24'
4	35° 08'	75° 38'
5	35° 04'	75° 52'
6	34° 51'	76° 11'
7	34° 36'	76° 24'
8	34° 24'	76° 19'
9	34° 21'	76° 27'
10	34° 33'	76° 48'
11	34° 16'	77° 25'
12	33° 44'	77° 46'
13	33° 30'	77° 31'
14	33° 28'	77° 35'
15	33° 36'	77° 55'
16	33° 34'	78° 28'
17	32° 59'	78° 52'
18	32° 59'	79° 02'
19	32° 31'	79° 30'
20	31° 57'	80° 27'
11	31° 42'	80° 24'
12	31º 31'	80º 33'
13	30º 43'	80º 49'
14	30º 30'	81º 01'
15	29º 45'	81º 01'
16	29º 31'	80º 58'
17	29º 13'	80º 52'
18	29º 13'	State/EEZ Boundary

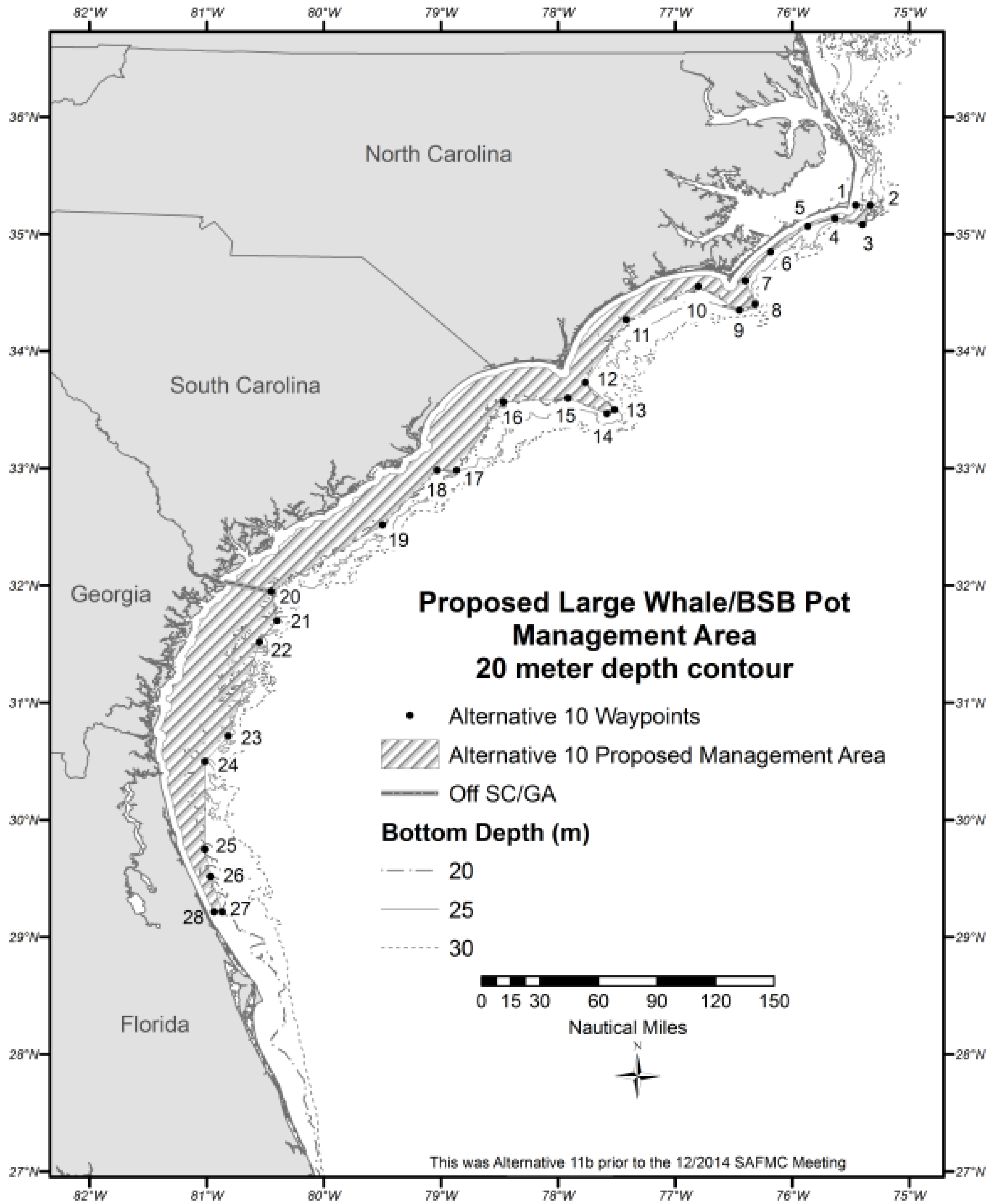


Figure B2.1.9. Area for the proposed black sea bass pot closure in Alternative 10 from November 1 through X.

Table B2.1.9. Eastern boundary coordinates for the proposed black sea bass pot closure in Alternative 10 for x through April 30.

Point	N. Latitude	W Longitude
1	35° 15'	State/EEZ Boundary
2	35° 15'	75° 09'
3	35° 06'	75° 22'
4	35° 06'	75° 39'
5	35° 01'	75° 47'
6	34° 54'	75° 46'
7	34° 52'	76° 04'
8	34° 33'	76° 22'
9	34° 23'	76° 18'
10	34° 21'	76° 27'
11	34° 25'	76° 51'
12	34° 09'	77° 19'
13	33° 44'	77° 38'
14	33° 25'	77° 27'
15	33° 22'	77° 40'
16	33° 28'	77° 41'
17	33° 32'	77° 53'
18	33° 22'	78° 26'
19	33° 06'	78° 31'
20	33° 05'	78° 40'
21	33° 01'	78° 43'
22	32° 56'	78° 57'
23	32° 44'	79° 04'
24	32° 42'	79° 13'
25	32° 34'	79° 23'
26	32° 25'	79° 25'
27	32° 23'	79° 37
28	31° 53'	80° 09'
29	31º 31'	80º 33'
30	30º 43'	80º 49'
31	30º 30'	81º 01'
32	29º 45'	81º 01'
33	29º 31'	80º 58'
34	29º 13'	80º 52'
35	29º 13'	State/EEZ Boundary

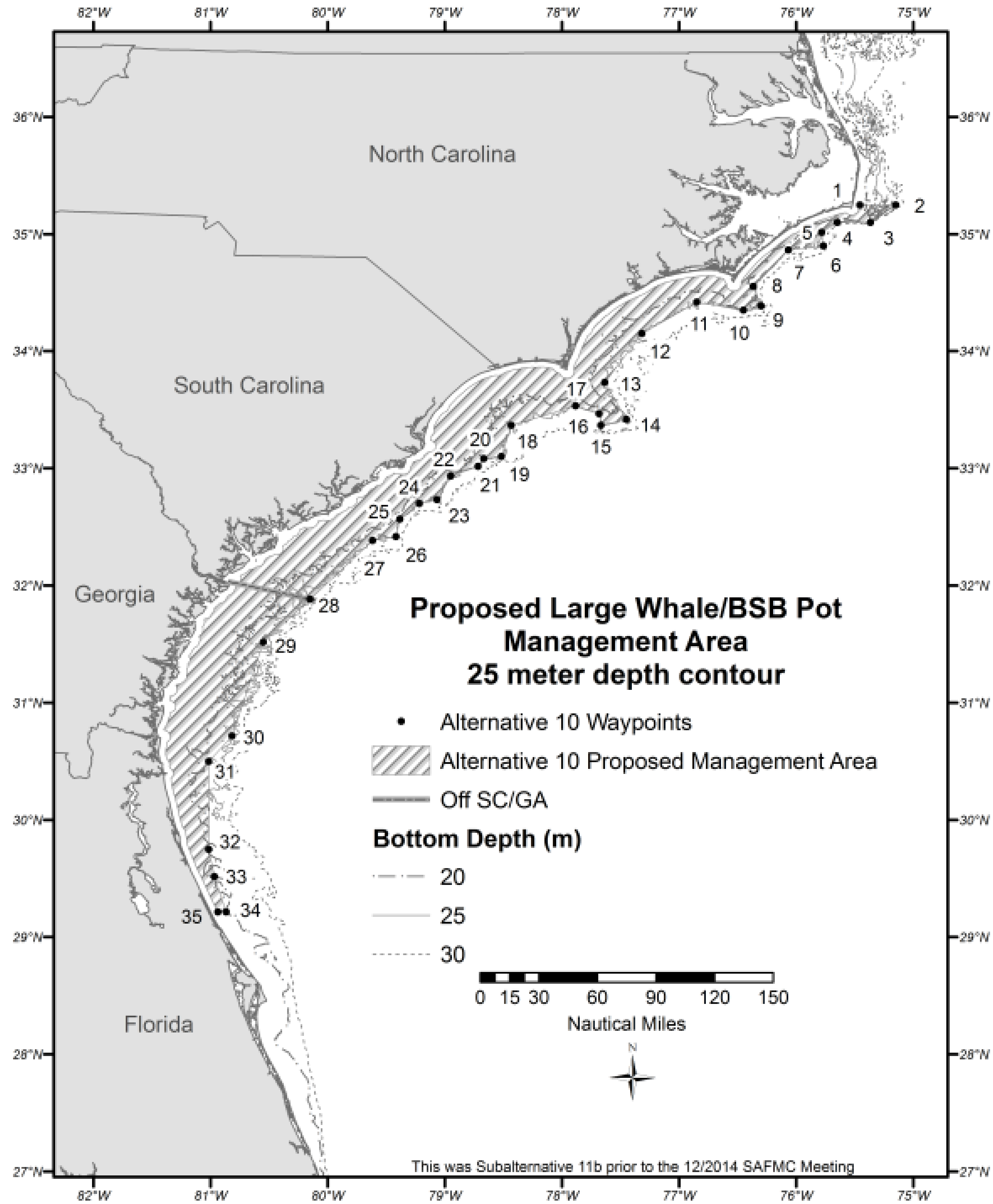


Figure B2.1.10. Area for proposed black sea bass pot closure in Alternative 10 from X through April 30.

APPENDIX C: NORTH CAROLINA RIGHT WHALE SIGHTINGS MODEL

Tim Gowan
FWC/FWRI
6/17/2014

Training data
Survey data from UNC Wilmington surveys (10/2005-4/2006, 12/2006-4/2007, and 2/2008-4/2008), obtained from OBIS-Seamap. Survey effort calculated as cumulative number of surveys (flights) per cell, across all survey months and years. Number of sightings calculated as cumulative number of right whales per cell, across all months and years.

Environmental data:
Distance to shore, depth, and slope calculated as in Gowan and Ortega-Ortiz 2014. SST summarized into semi-monthly averages (as in Gowan and Ortega-Ortiz 2014), then 'countSST' (number of semi-monthly periods with available data) and 'avgSST' calculated from 80 semi-monthly periods (Dec03-Mar13).

Started with 5642 sampling units/cells (22 cells with sightings, 24 groups, 48 whales). Removed cells with no surveys; where DistToShore=-999 (on land); where slope=0.00 (null); and where 'countSST' < 15 (623 cells remaining for analysis, 23 groups, 45 whales).

Model framework and selection
Note that there is no temporal component to this model – just used cumulative sightings and effort (across all months and years with survey data) and long-term winter SST – due to limited data.

Used a GAM with quasibinomial distribution (to deal with excessive number of zeros) with a logit link to model presence-absence of right whale sightings. log(Surveys) used as offset term in model; log(Depth), log(Slope), DistToShore, and avgSST considered as predictor variables; basis dimension parameter set to 3 and gamma term set to 1.4 to avoid overfitting.

Model selection was accomplished with a forward stepwise selection procedure, using the following evaluation criteria: model GCV scores (Table 1), percentage of deviance explained (Table 1), analysis of deviance tests (Table 2), and average squared prediction error from a five-fold cross-validation (Table 1) [all as in Gowan and Ortega-Ortiz 2014].

Table 1

Step	Model	% Deviance	GCV	mean ASPE
1	**Null**	**0.0**	**0.3003**	0.03032
2	s(log(Depth))	1.84	0.2962	0.03031
2	**s(DistToShore)**	**3.74**	**0.2904**	0.03031
2	s(log(Slope))	3.61	0.2920	0.03029
2	s(avgSST)	2.93	0.2940	0.03031
3	s(DistToShore) + s(log(Depth))	4.38	0.2907	0.03030

3	**s(DistToShore) + s(log(Slope))**	**6.88**	**0.2844**	0.03028
3	s(DistToShore) + s(avgSST)	5.17	0.2885	0.03031
4	s(DistToShore) + s(log(Slope)) + s(log(Depth))	8.05	0.2817	0.03027
4	**s(DistToShore) + s(log(Slope)) + s(avgSST)**	**8.42**	**0.2812**	0.03028
5	**s(DistToShore) + s(log(Slope)) + s(avgSST) + s(log(Depth))**	**9.11**	**0.2800**	0.03027

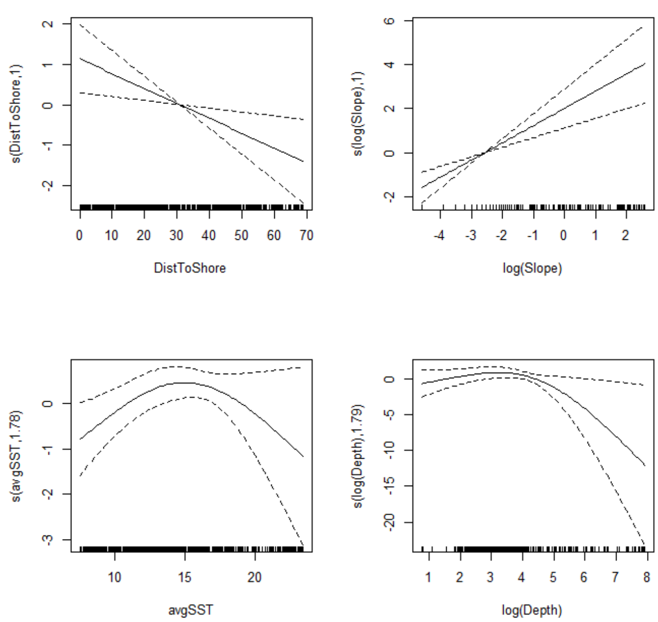
Table 2

Model	Estimated df	Residual Deviance	Reduction in Deviance	*F*	*p*
null	1.00	186.3			
Step2	2.00	179.3	6.96	24.1	<0.001
Step3	4.67	173.5	5.86	7.8	<0.001
Step4	5.89	170.6	2.87	8.5	<0.01
Step5	6.57	169.3	1.28	6.8	<0.05

<u>Results</u>

Selected model, as formulated in R:

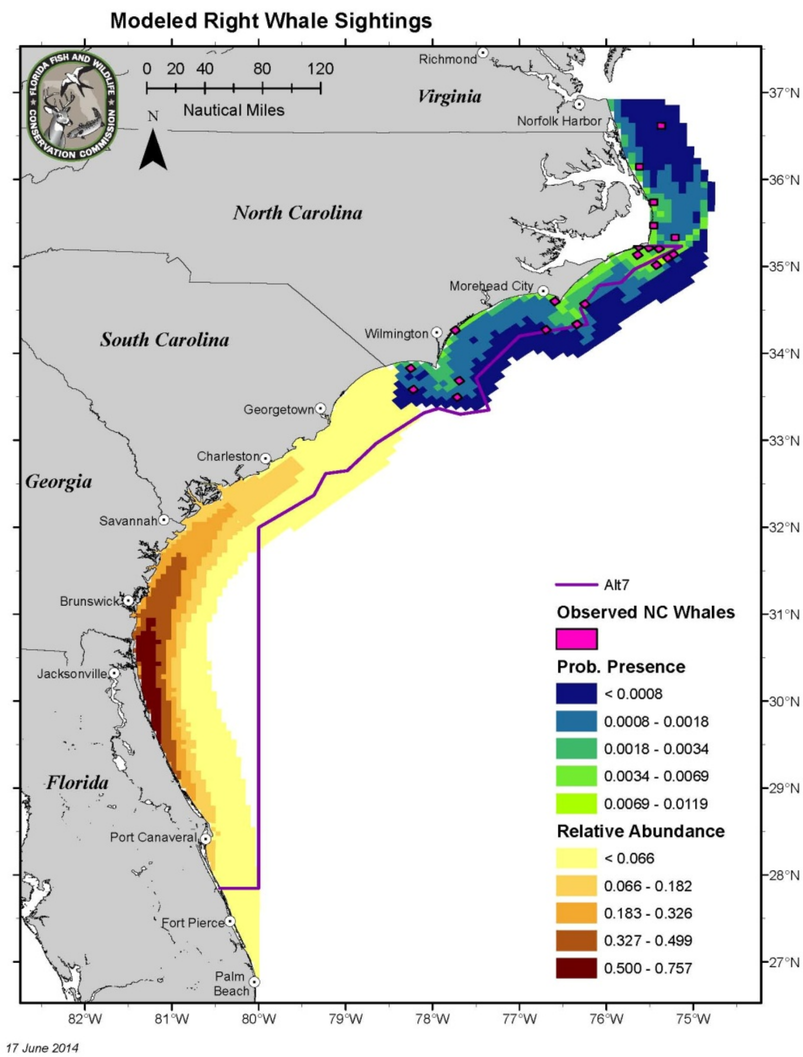
gam(Presence ~ s(DistToShore,k=3) + s(log(Slope),k=3) + s(avgSST,k=3) + s(log(Depth),k=3), family=quasibinomial(link='logit'), offset=log(Surveys), gamma=1.4)



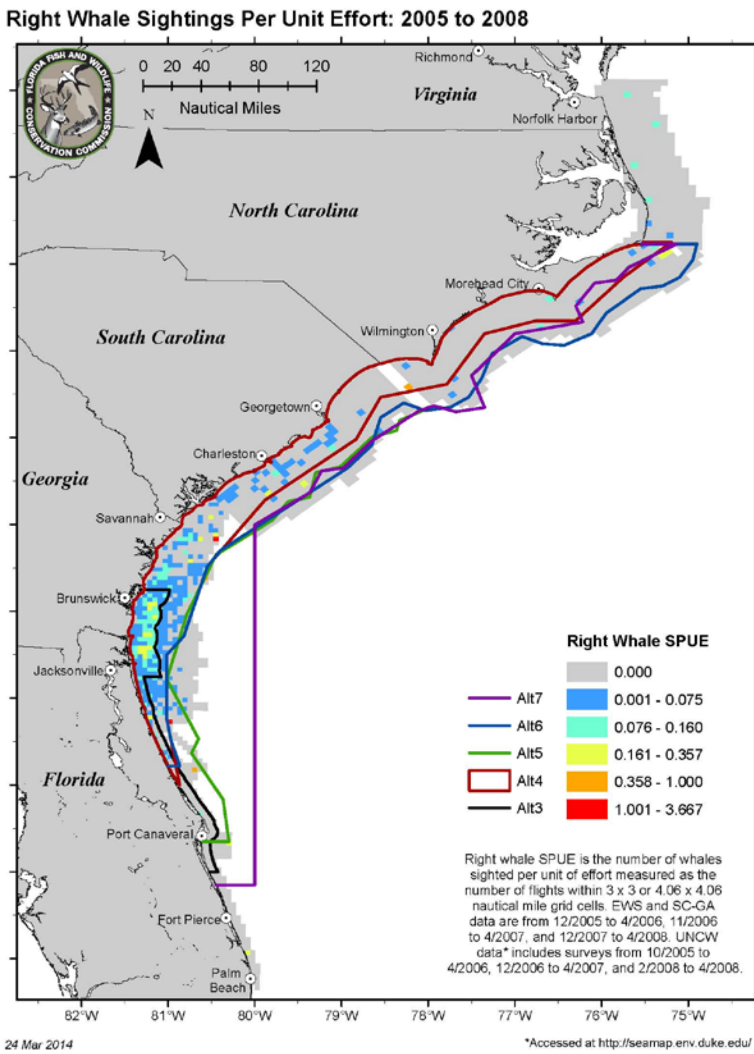
<u>Predictions</u>
Only made predictions within the range of the training data [(0 < DistToShore <= 69) and (2 < Depth < 2742) and (33.38 <= Lat <= 36.89) and (-78.42 <= Long <= -74.79) and (0 < Slope <= 13.21) and (countSST >= 15)] – in 704 cells.

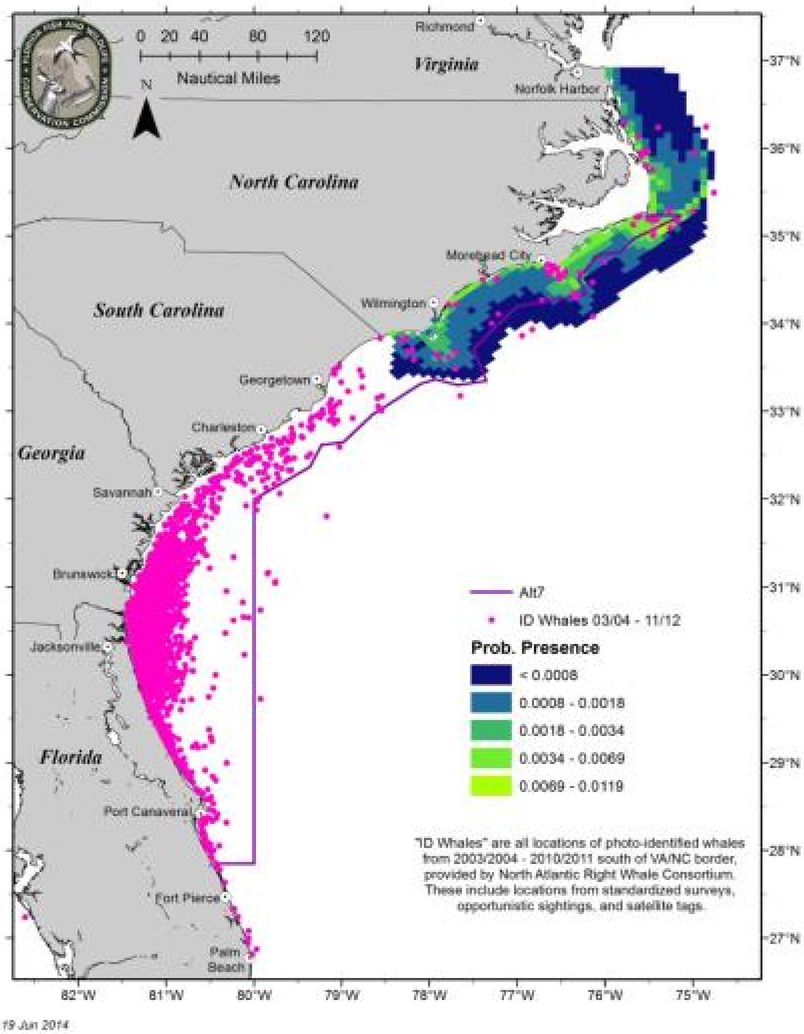
Survey data, environmental data, predicted probability of right whale presence ('pres'), and standard errors around predictions ('pres_se').

***Note: Predicted values from this NC model do not have the same scale or interpretation as the values from the SEUS model (Gowan and Ortega-Ortiz 2014) and are not directly comparable. Differences include survey design, resolution/quantification of survey effort, temporal components in the model, model framework (probability of presence vs. relative abundance), whale behavior (e.g. sighting availability bias in migratory corridor vs. calving grounds), etc.

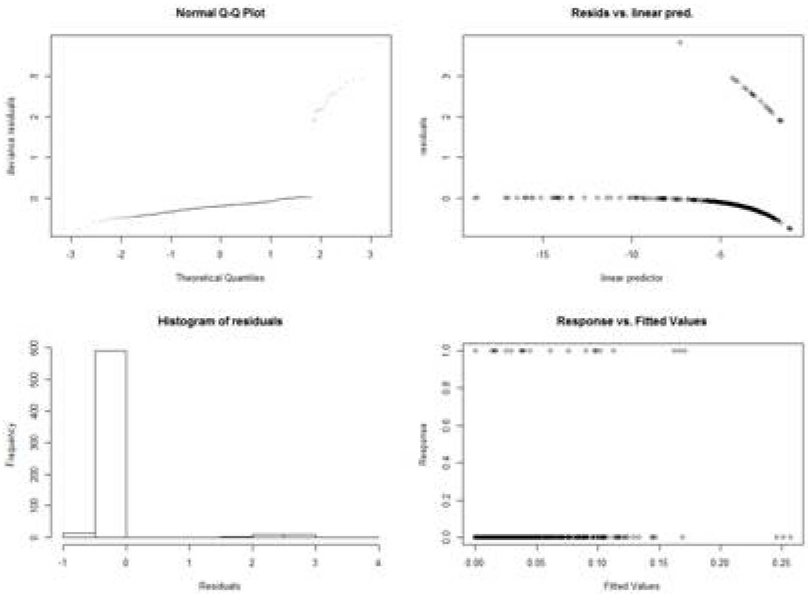


<u>Comparing Predictions to Observations</u>




0 20 40 80 120
Nautical Miles
N
Richmond
Virginia
Norfolk Harbor
North Carolina
Morehead City
Wilmington
South Carolina
Georgetown
Charleston
Georgia
Savannah
Brunswick
Jacksonville
Florida
Port Canaveral
Fort Pierce
Palm Beach
Alt7
ID Whales 03/04 - 11/12
Prob. Presence
< 0.0008
0.0008 - 0.0018
0.0018 - 0.0034
0.0034 - 0.0069
0.0069 - 0.0119
"ID Whales" are all locations of photo-identified whales from 2003/2004 - 2010/2011 south of VA/NC border, provided by North Atlantic Right Whale Consortium. These include locations from standardized surveys, opportunistic sightings, and satellite tags.
37°N
36°N
35°N
34°N
33°N
32°N
31°N
30°N
29°N
28°N
27°N
82°W
81°W
80°W
79°W
78°W
77°W
76°W
75°W
19 Jun 2014

Residual plots for zero-inflated model fits



APPENDIX D: Gowan and Ortega-Ortiz (2014)
{AVAILABLE FREE AT: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0095126}

Warm/Cold Winter Right Whale Distribution

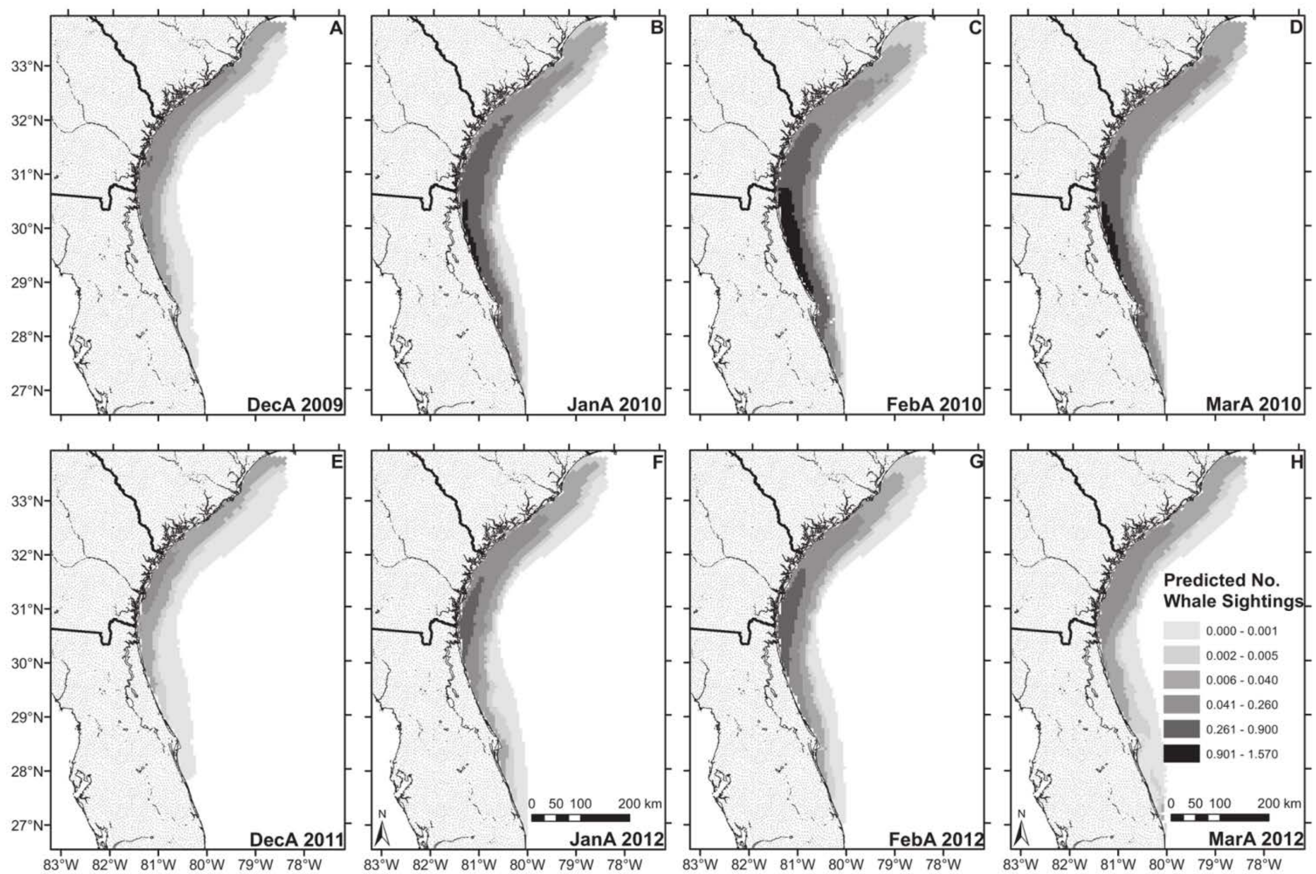


FIGURE 5: Predicted right whale relative abundance.

Values represent predicted number of sighted right whales per grid cell (assuming uniform survey effort) during the 2009/2010 calving season (a relatively cold season with high sighting rates) for December 1–15 (A), January 1–15 (B), February 1–15 (C), and March 1–15 (D); and during the 2011/2012 calving season (a relatively warm season with low sighting rates) for December 1–15 (E), January 1–15 (F), February 1–15 (G), and March 1–15 (H).
doi:10.1371/journal.pone.0095126.g005

APPENDIX E: Sensitivity Run – Monthly North Carolina Whale Distribution Model

Introduction

Insufficient right whale sightings data off North Carolina were available to directly fit a model comparable to the Gowan & Ortiz-Ortega (2014) model for FL-SC. As described in Appendix C, Dr. Gowan fit the NC model using the same modeling approach as described in Gowan & Ortega-Ortiz (2014), but aggregated right whale sightings data across all months (Dec-Mar) to obtain sufficient sample size for a statistically robust approach.

The SAFMC SSC requested additional analysis of monthly trends off NC, if possible. Dr. Gowan determined the data could support this approach if driven by whale responses to the most dynamic environmental factor (SST) rather than by the monthly sightings data. The model described in Appendix C was used to generate monthly predictions by using monthly means for SST rather than a long term Dec-Mar average of SST as in the original analysis. Thus, monthly differences in predictions are based solely on predicted whale responses to monthly differences in SST and not on modeled whale abundance/migration.

Methods

Training data

Survey data from UNC Wilmington surveys (10/2005-4/2006, 12/2006-4/2007, and 2/2008-4/2008), obtained from OBIS-Seamap. Survey effort calculated as cumulative number of surveys (flights) per cell, across all survey months and years. Number of sightings calculated as cumulative number of right whales per cell, across all months and years.

Environmental data:

Distance to shore, depth, and slope calculated as in Gowan and Ortega-Ortiz 2014. SST summarized into semi-monthly averages (as in Gowan and Ortega-Ortiz 2014), then 'countSST' (number of semi-monthly periods with available data) and 'avgSST' calculated from 80 semi-monthly periods (Dec03-Mar13).

Started with 5642 sampling units/cells (22 cells with sightings, 24 groups, 48 whales). Removed cells with no surveys; where DistToShore=-999 (on land); where slope=0.00 (null); and where 'countSST' < 15 (623 cells remaining for analysis, 23 groups, 45 whales).

Model framework and selection

Note that there is no temporal component to this model – just used cumulative sightings and effort (across all months and years with survey data) and long-term winter SST – due to limited data.

Used a GAM with quasibinomial distribution (to deal with excessive number of zeros) with a logit link to model presence-absence of right whale sightings. log(Surveys) used as offset term in model; log(Depth), log(Slope), DistToShore, and avgSST considered as predictor variables; basis dimension parameter set to 3 and gamma term set to 1.4 to avoid overfitting.

Model selection was accomplished with a forward stepwise selection procedure, using the following evaluation criteria: model GCV scores (Table E1), percentage of deviance explained (Table E1), analysis of deviance tests (TableE2), and average squared prediction error from a five-fold cross-validation (Table E1) [all as in Gowan and Ortega-Ortiz 2014].

Table E1

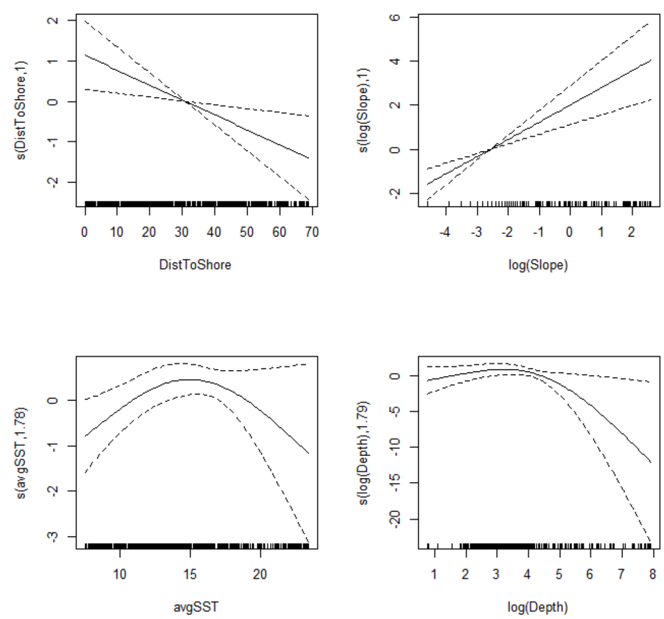
Step	Model	% Deviance	GCV	mean ASPE
1	**Null**	**0.0**	**0.3003**	0.03032
2	s(log(Depth))	1.84	0.2962	0.03031
2	**s(DistToShore)**	**3.74**	**0.2904**	0.03031
2	s(log(Slope))	3.61	0.2920	0.03029
2	s(avgSST)	2.93	0.2940	0.03031
3	s(DistToShore) + s(log(Depth))	4.38	0.2907	0.03030
3	**s(DistToShore) + s(log(Slope))**	**6.88**	**0.2844**	0.03028
3	s(DistToShore) + s(avgSST)	5.17	0.2885	0.03031
4	s(DistToShore) + s(log(Slope)) + s(log(Depth))	8.05	0.2817	0.03027
4	**s(DistToShore) + s(log(Slope)) + s(avgSST)**	**8.42**	**0.2812**	0.03028
5	**s(DistToShore) + s(log(Slope)) + s(avgSST) + s(log(Depth))**	**9.11**	**0.2800**	0.03027

Table E2

Model	Estimated df	Residual Deviance	Reduction in Deviance	*F*	*p*
null	1.00	186.3			
Step2	2.00	179.3	6.96	24.1	<0.001
Step3	4.67	173.5	5.86	7.8	<0.001
Step4	5.89	170.6	2.87	8.5	<0.01
Step5	6.57	169.3	1.28	6.8	<0.05

Final Model

Selected model, as formulated in R:
gam(Presence ~ s(DistToShore,k=3) + s(log(Slope),k=3) + s(avgSST,k=3) + s(log(Depth),k=3), family=quasibinomial(link=’logit’), offset=log(Surveys), gamma=1.4)



Results

Predictions were made within the range of the training data [(0 < DistToShore <= 69) and (2 < Depth < 2742) and (33.38 <= Lat <= 36.89) and (-78.42 <= Long <= -74.79) and (0 < Slope <= 13.21) and (countSST >= 15)] – in 704 cells. Long-term mean monthly SST was calculated from 10 years of data (December 2003 – March 2013) and used to generate monthly predictions.

Summary Outputs from Sensitivity Run:

The Reg-16 analysis was re-run using the monthly NC right whale distribution model data for Dec-Mar, with Dec used as a proxy for Nov and Mar used as a proxy for Apr. Projected closure dates and relative right whale entanglement risk were summarized by spatial scenario, catch rate scenario, and Reg-16 proposed alternative (Table E3, Figure E1). The incorporation of monthly data for NC right whale distribution had very little impact on the projected effects of Reg-16 alternatives with regards to relative right whale risk (Table E4). Impacts ranged from 0-5 relative risk units. The greatest impact was observed for Alternatives 7c, which showed slightly reduced risk under this sensitivity run. By contrast, Alternatives 8b and 9b showed slightly increased risk. It is important to note that this model is based on predicted right whale responses to mean monthly sea surface temperature. Due to data limitations, the model was unable to account for temporally unique right whale behavioral dynamics.

Note: Predicted values from this NC model do not have the same scale or interpretation as the values from the SEUS model (Gowan and Ortega-Ortiz 2014) and are not directly comparable. Differences include survey design, resolution/quantification of survey effort, temporal components in the model, model framework (probability of presence vs. relative abundance), whale behavior (e.g. sighting availability bias in migratory corridor vs. calving grounds), etc.

Table E3. Monthly NC Model sensitivity run projected commercial black sea bass closure dates, percent of ACL reached, and risk of right whale entanglement in pot gear vertical lines (in relative risk units) under proposed Alternatives in Regulatory Amendment 16.

MEAN CONDITIONS		Alt1	No Closure				Alt2				Alt3				Alt4				Alt5				Alt6				Alt7a			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/5	10/12	10/28	12/3	12/30	12/22	12/18	12/30	12/24	12/11	12/11	12/23	12/29	12/21	12/18	12/29	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	15	11	11	15	2	2	2	2	2	2	2	2	2	2	2	2	71	71	71	71
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	48	47	47	48	0	0	0	0	37	37	37	37	0	0	0	0	94	94	94	94
Scenario B	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	12/3	10/17	11/4	12/2	12/28	12/19	12/18	12/29	12/18	12/2	12/8	12/17	n/a	12/25	12/20	n/a	10/12	8/20	10/9	10/9
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	27	21	22	26	8	8	8	8	2	1	2	2	8	8	8	8	66	66	66	66
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	30	29	29	30	2	2	2	2	43	42	42	43	0	0	0	0	77	77	77	77
Scenario C	Closure Date	n/a	10/2	8/4	9/20	9/27	10/2	8/4	9/20	9/27	11/26	10/4	10/26	11/19	12/20	12/7	12/11	12/19	12/16	12/1	12/6	12/15	12/20	12/7	12/10	12/19	10/11	8/18	10/6	10/7
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	100	100	100	100	100	100	100	100	17	14	14	16	3	3	3	3	2	2	2	2	3	3	3	3	68	68	68	68
	RW Risk (FL-SC)	0	100	100	100	100	100	100	100	100	44	43	43	44	1	1	1	1	34	33	33	34	0	0	0	0	84	84	84	84

MEAN CONDITIONS		Alt1	Alt7b				Alt7c				Alt8a				Alt8b				Alt9a				Alt9b				Alt10			
		SQ	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Scenario A	Closure Date	n/a	n/a	12/30	12/21	n/a	12/28	12/17	12/14	12/29	12/11	10/24	10/31	12/9	n/a	12/30	12/21	n/a	10/31	9/20	10/15	10/27	n/a	12/28	12/20	n/a	n/a	12/29	12/20	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	98%	100%	100%	100%	100%	99%	100%	100%	99%	99%	100%	100%	99%
	RW Risk (NC)	0	79	78	74	79	84	79	78	85	15	14	14	15	54	53	49	54	27	27	27	27	64	63	59	64	58	57	53	58
	RW Risk (FL-SC)	0	98	97	92	98	91	85	83	92	40	38	38	39	81	79	74	81	62	62	62	62	90	87	83	90	81	79	74	81
Scenario B	Closure Date	n/a	12/28	12/18	12/17	12/28	12/22	12/9	12/11	12/23	12/7	10/25	11/5	12/6	12/29	12/20	12/18	12/29	11/9	9/27	10/19	11/3	12/26	12/15	12/14	12/26	12/27	12/17	12/16	12/28
	%ACL	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RW Risk (NC)	0	84	75	74	84	94	82	84	95	37	31	32	37	67	58	57	67	52	50	50	50	85	76	75	85	73	64	63	74
	RW Risk (FL-SC)	0	73	70	70	73	70	67	67	71	50	48	49	50	65	62	61	65	57	56	56	56	71	68	68	71	65	62	62	66
Scenario C	Closure Date	n/a	n/a	12/27	12/19	n/a	12/27	12/16	12/13	12/28	12/6	10/17	10/29	12/5	n/a	12/28	12/20	n/a	10/28	9/15	10/13	10/24	12/31	12/24	12/17	n/a	n/a	12/25	12/18	n/a
	%ACL	97%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
	RW Risk (NC)	0	88	82	74	88	101	90	87	102	20	18	18	20	64	59	51	64	36	36	36	36	82	77	68	82	71	71	71	71
	RW Risk (FL-SC)	0	92	89	84	92	85	78	76	86	37	36	36	37	76	74	68	76	56	56	56	56	84	79	74	84	77	72	68	77

Sensitivity Runs: Mean conditions whale distribution, catch rate projection scenarios 1-4 (i.e., observed 2008/09 winter catch rates, observed 2013/14 summer catch rates scaled to account for higher winter CPUE, observed 2013/14 summer catch rates, and mean observed 2006/07-2008/09 winter catch rates) and spatial fishing distribution scenarios A-C (i.e., based on Nov-Apr 2008/09 pot distribution with 2013/14 soak times, based on 2013/14 June-October pot distribution and soak times, based on mean Nov-Apr 2006/07-2008/09 pot distribution with 2013/14 soak times).

Table E4. Differences in North Atlantic right whale relative risk units between annual (see Table 2A) and monthly NC model (see Table E3).

Catch Rate	Trap Distribution	1	NC	2	3	4	5	6	7a	7b	7c	8a	8b	9a	9b	10
1	A	0	0	0	0	0	0	0	3	2	-4	-1	1	-1	1	1
	B	0	0	0	0	0	0	0	2	2	-2	-1	2	-1	1	2
	C	0	0	0	0	0	0	0	3	1	-5	-1	0	-1	0	0
2	A	0	0	0	-1	0	0	0	3	2	-3	-1	1	-1	1	1
	B	0	0	0	-1	0	0	0	2	3	-1	-2	2	-1	2	2
	C	0	0	0	-1	0	0	0	3	2	-4	-1	1	-1	0	0
3	A	0	0	0	-1	0	0	0	3	3	-3	-1	2	-1	2	2
	B	0	0	0	-1	0	0	0	2	3	-1	-1	2	-1	2	2
	C	0	0	0	-1	0	0	0	3	3	-4	-1	2	-1	1	0
4	A	0	0	0	0	0	0	0	3	2	-4	-1	1	-1	1	1
	B	0	0	0	0	0	0	0	2	2	-2	-1	2	-1	1	2
	C	0	0	0	0	0	0	0	3	1	-6	-1	0	-1	0	0

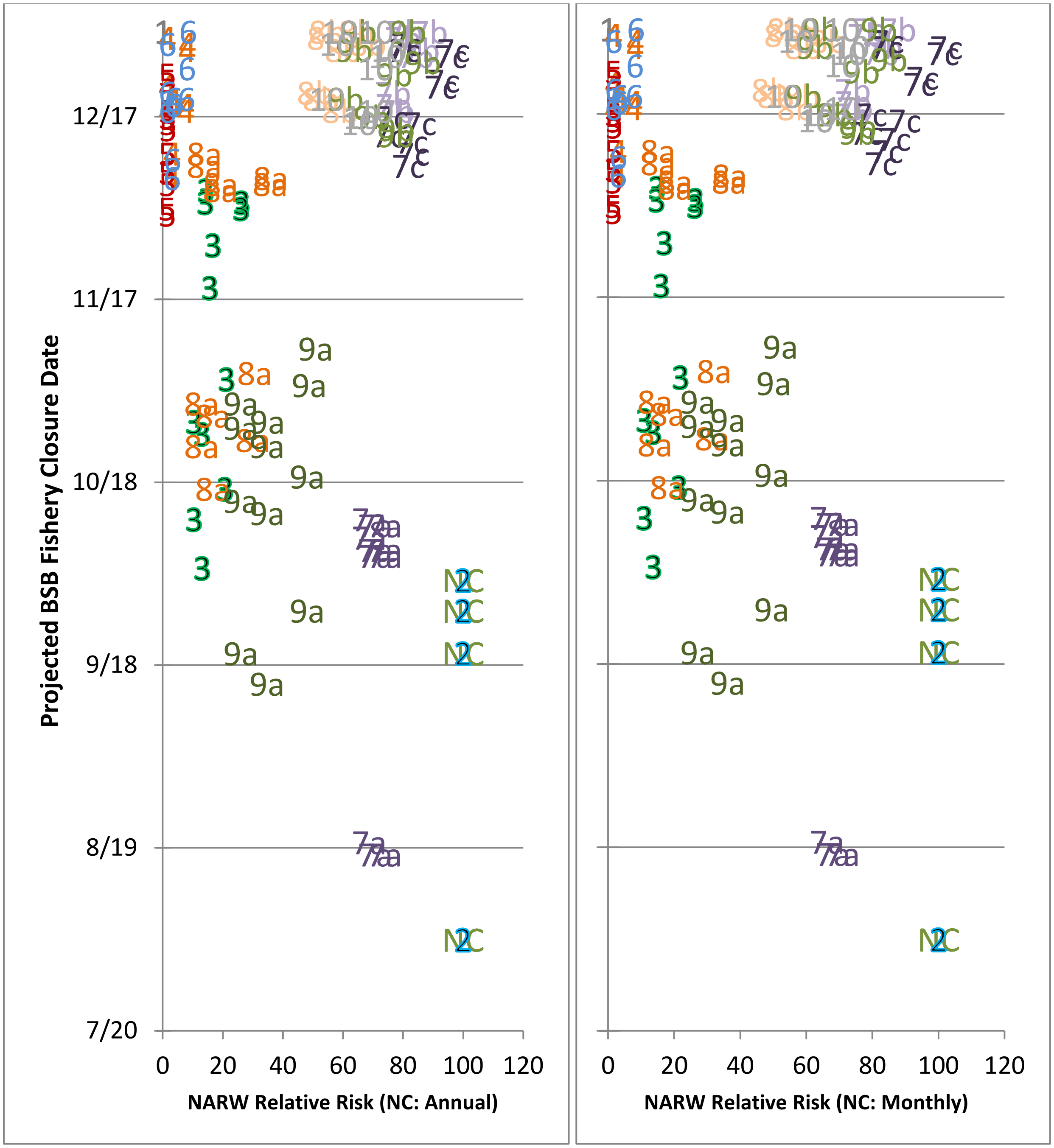


Figure E1. Projected closure date versus North Atlantic right whale (NARW) relative risk off North Carolina for Annual (left) and Monthly (right) models, by alternative (colored numbers), across catch rate scenarios 1-4 and spatial pot gear distribution scenarios A-C, for right whale distributions under mean conditions. Number/letter combinations included in the graph correspond to alternatives in Reg-16. North Carolina data modeled based on monthly predictions of right whale distribution based on mean monthly sea surface temperatures (SST).

APPENDIX F: Evaluation of Within-Scenario Uncertainty

At their October 2014 meeting, the SAFMC SSC recommended within scenario model uncertainty be evaluated to determine if projected differences between alternatives were statistically robust. SERO staff worked with Tim Gowan (FWC) to generate 95% confidence intervals (based on the inter-annual variation in modeled whale relative abundance) for the FL-SC and NC right whale models presented in the main body of this report. Within-scenario uncertainty was evaluated using these confidence limits for the right whale distribution model. Lower confidence limits were bounded at zero within model cells, consistent with the use of a quasibinomial distribution (Gowan & Ortega-Ortiz 2014, Gowan pers. comm.). The other components of the model (distribution of fishery effort, fishery catch rate) were treated as deterministic within-scenarios, with uncertainty in these components evaluated exclusively through the 'bookending' of a range of realistic scenarios. In general, within-model uncertainty was low, and model-projected differences between alternatives appeared to be statistically robust (Figure F1). Within-model uncertainty was highest for Alternatives 3, 5, and 7b-9b; however, these alternatives remained distinctly separated from Alternatives 4 and 6, which provided the lowest relative right whale risk of any pot gear fishery opening considered in Reg-16.

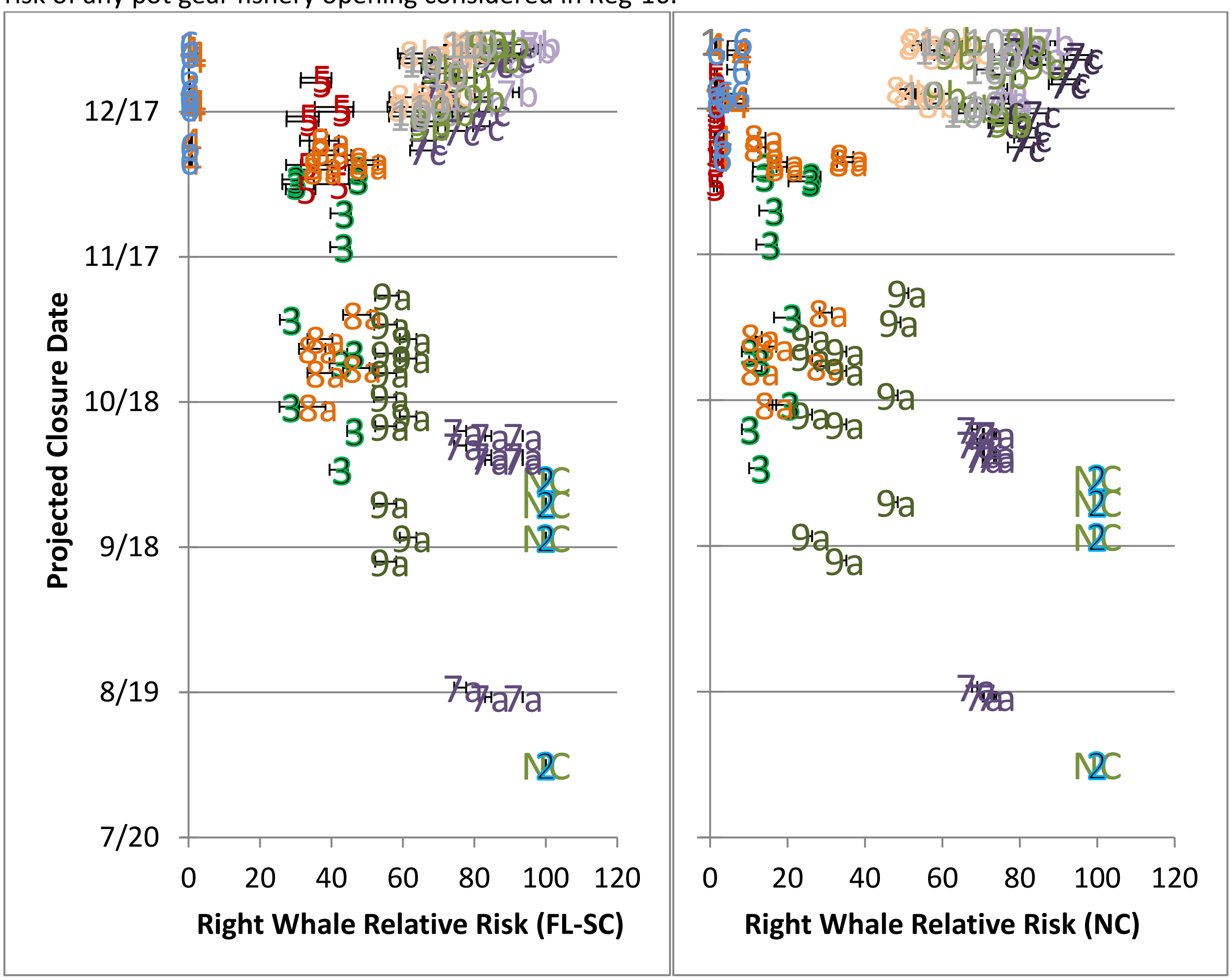


Figure F1. Projected closure date versus relative right whale risk, by alternative (colored numbers), across catch rate scenarios 1-4 and spatial pot gear distribution scenarios A-C, for right whale distributions under mean conditions. Number/letter combinations included in the graph correspond to alternatives in Reg-16. Error bars denote 95% confidence limits. Compare to Figure 11A.